EVOLVE YOUR HISTORY: LEARNER ENGAGEMENT IN THE UNIVERSITY HISTORY CLASSROOM EXPLORED THROUGH AUGMENTED REALITY

by

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Abstract

This thesis presents research results on Augmented Reality (AR) from an educational engagement point of view, sharing findings on how AR can be deployed in history classrooms to potentially increase learner engagement. In modern historical educational practices, students are often only moderately engaged, and increasing engagement using AR remains largely unexplored. This study surveyed 19 history students in phase one, and 15 students in phase two with observations in both phases, fieldnotes, and interviews with four British Columbian university students. Overall data analysis suggested that AR did not increase student engagement under an already engaging history professor, although qualitative data suggested that students were engaged with AR and classmates in this study. Participant feedback identified that engagement could be increased through dramatic historical topics such as WW 1, using AR with elementary and high school students, AR tutorial sessions, defined timelines, and feedback on potential barriers in the classroom.

Keywords: Augmented Reality, Student engagement, Neomillennial, Modern Curriculum, Educational technology, Teacher engagement, Historical educational methods

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Chapter 1
Modern Historical Education

History is usually seen through the lens of antiquity, primary sources, contemporary reports, textbooks, and journal articles (Goodin, 2012; Luckhardt, 2014), or in relation to modern society and its concurrent issues. This *dusty* viewpoint has given history classrooms a dull environment wherein students are not engaged to their fullest intellectual potential (Savich, 2009; Waring & Robinson, 2010). This means that history is not seen as the most interesting and relevant subject as shown by Statistics Canada (2004) which showed history was the least interesting subject in schools. As presented by Cheung and Slavin (2012), the rapid growth, availability, and the ever-changing evolution of technologies – specifically educational technologies – make it increasingly difficult to determine how to incorporate them into the classroom (Karich Burns, & Maki, 2014). Ideally, the effective use of educational technology, such as Power Points and Moodle and augmented reality (AR) environments, would be accomplished by creating classrooms that are connected to the Internet of Things (IoT) allowing the students to adapt to new information and ideas. These would be dedicated to technological modularity and the use of virtual and AR environments to create what could be termed *living history* (Mayrose, 2012). This could also be called *experiential history*.

Professors and other educators have the opportunity to use many kinds of educational technology; unfortunately, it is possible to miss or lose sight of critical objectives, including student to student engagement and engagement with the topic when doing so. Furthermore, the use of cell phones is pervasive in current society; students often use them to connect to others or as entertainment devices, thus overlooking or misunderstanding the educational value they can represent. Educators have the potential to improve their connection to students in relation to history pedagogy if they use and incorporate educational technology in the classroom for the benefit of the student and themselves (Lee, Waxman, Wu, Michko, & Lin, 2013). Educational technology has the potential for increased learning and engagement and this links to the teacher's connection to their students by way of engagement. Additionally, teachers less familiar with modern technology could potentially increase student engagement by learning how to use modern

technology competently and efficiently. Students, as persons usually fluent with digital technology, could be shown that their cell phone or tablet, by providing connections and entertainment, also delivers a wide scope of collected human knowledge, experience and understanding (Goodin, 2012; Ladbrook & Prober, 2011; Prensky, 2001). The new method of teaching could encompass the neo-millennial environment where students are no longer overlooking information (Dede 2005). It may be useful to combine educational technology such as AR, haptics-touch sensory devices, online media, and multi-media applications with novel and traditional in-class history education to create an immersive foundation for student engagement while keeping students grounded in the real world. This could potentially create a sense of wonder and appreciation that cannot be gained from a textbook, and bring history to life in an interactive, livable, touchable experience which Luckhardt (2014) called *historical literacy*.

History has been given less attention in main stream education, and as Savich (2009) pointed out, rendered dull by poor public opinion and higher emphasis on the Science, Education, Technology, and Math (S.T.E.M) fields (Statistics Canada, 2004). Instruction in history is critical for students to learn about their own county's past, and to understand its role in a glocal-global context (Watts, 2017; Weber, 2007). Furthermore, they gain the abilities to explain and reproduce historical information, and learn how to deal with source bias. Additionally, they acquire the ability to discern fragmentary information, and gain an appreciation for how far civilizations and cultures have progressed over 15,000 years since the first societies were established. Technology can facilitate this understanding (Seixas, 1999).

Technology has seen mixed results in its deployment for educational purposes (Celik, & Yesilyurt, 2013; Singh, & Hurley, 2017; Venkatesh, Croteau, & Rabah, 2014). Many teachers are enthusiastic about technology and a key cornerstone of their education, (Açikalin, 2010) while others may shun it due to logistical issues unique to the school environment, lack of adequate technical support, and old equipment. Technology will continue to drive cultural and social change and educators have a duty to teach using methods that are relevant and engaging to the current generation of students (Prensky, 2014).

Engagement is key to success in education (Fredricks, Filsecker, & Lawson, 2016; Kuh, 2003). A student can be engaged with the content of the class or course when they actively seek knowledge from sources, interact with educators and other students on a level in which they are comfortable, and when they can explain the historical significance of the topic with insight. This is not developed during a single class, but is encouraged over time. Engagement with content is cultivated over a period when the student gains familiarity with the content and engages with the instructor and the teaching methods used. Thus, engagement is another cornerstone of educational success.

AR was relegated to a niche market until the release of Pokémon GO in early July of 2016, which has introduced AR to mainstream media and populace (VentureBeat, 2016). This in turn has caused businesses to look for ways to profit from the technology, making it possible for AR to become a multi-billion-dollar market by the year 2020 (VentureBeat, 2016). AR has the potential to immerse students in content without the difficulty inherent to using virtual reality (VR), which requires headsets that can reduce engagement with the physical space (Echeverría, Gil, & Nussbaum, 2016). AR can have students searching and interacting with the historical content outside the physical classroom, and responds to calls for a more active society (Kreizer, 2016).

This paper will present research that examines the effects of AR on student engagement. The following will be discussed: Modern historical education and its implications, modern technology and its current use in the education system, the engagement of students in the classroom, and AR technology. Furthermore, a potential AR curriculum could be created based upon the results of the literature review. The researcher followed calls by Egan and Judson (2009) and Prensky (2014) for a new and modern curriculum that caters to student needs, and continued research by Schrier (2005) and Squire and Jan (2007) by creating an AR game that taught history to students. The research examined the results of emerging AR technology from an educational engagement point of view, and shared findings on how AR can be deployed in history classrooms to potentially increase learner engagement.

Defining Key Terms

The key terms used in the study are defined below.

Engagement. This refers to the degree of attention, curiosity, interest, optimism, and passion that students show when they are learning or being taught, which extends to the level of motivation they must learn and progress in their education. The concept of *student engagement* is predicated on the belief that learning improves when students are inquisitive, interested, or inspired, and that learning tends to suffer when students are bored, dispassionate, disaffected, or otherwise *disengaged* (Hidden Curriculum, 2014).

Student to Student engagement. Refers to the positive or negative relationship of students interacting with classmates in a work-related environment. This study looked at the interactions between students in an AR environment and asked questions to determine if an increase in student to student engagement occurred. Kuh (2003) defines engagement as follows:

> The engagement premise is straightforward and easily understood: the more students study a subject, the more they know about it, and the more students practice and get feedback from faculty and staff members on their writing and collaborative problem solving, the deeper they come to understand what they are learning and the more adept they become at managing complexity, tolerating ambiguity, and working with people from different backgrounds or with different views (p. 5).

Kuh explains another way engagement helps to develop habits of the mind and heart that enlarge their capacity for continuous learning and personal development (2003). This describes what the study seeks to obtain: an increase in engagement with students working with their peers on an interesting topic.

Teacher-Student engagement. The positive or negative engagement that constitutes a student-teacher bond. The definition is the same as above; students are engaged with the faculty and obtain feedback and increased interest in the topic (Cornelius-White,

2007; Crosnoe, Johnson, & Elder Jr, 2004; Hamre, & Pianta, 2006; Klem, & Connell, 2004; Kuh, 2003; Roorda, Koomen, Spilt, & Oort, 2011).

Historical research methods. This is a group of techniques and guidelines that a historian uses when examining a primary, secondary, or tertiary source of evidence, to research and write a historical account of the past, usually within in a specific topical area. Furthermore, they are used to analyse contradictory sources (Howell & Prevenier, 2001). This study will look at these methods and ask if students were able to use them in the AR phase.

Neomillennial. This is a broad term that is concerned with creating learning materials that are focused towards a range of different learning styles, abilities, student backgrounds, and familiarity with technology (Bennet, Malton, & Kervin, 2008; Dede, 2005; Helsper & Eynon, 2009). This can include multimedia applications, group learning; experiential, collective and guided education; non-linear teaching, and co-design of educational materials (Dede, 2005). A Millennial could be a student that has experienced the technological revolution that includes personal computers and cell phones and is familiar, but may not always be fluent, with technology (Bennet, Malton, & Kervin, 2008; Dede, 2005; Helsper & Eynon, 2009; Oblinger, 2003) These people also may have different learning styles than the previous generation as they have been more exposed to different technologies (Jonas-Dwyer & Pospisil, 2004). This is different than that of a Neomillennial, who can be described as having experienced technology and very rarely experiences it without a cell phone or instant information, again with the associated familiarity or lack thereof (Bennet, Malton, & Kervin, 2008; Dede, 2005; Helsper & Eynon, 2009). This is different from the digital native and immigrant defined Prensky, (2014) who only defines them by age ranges and not ability with technology based on numerous real-life factors (Bennet, Malton, & Kervin, 2008; Helsper & Eynon, 2009). Furthermore, Prensky (2014) links Neomillenials to a drastic change in education while Bennet, Malton, and Kervin, (2008) liken this research to a moral panic and lacking an empirical definition. This definition is an evolution rather than a revolution in education. Furthermore, Neomillennial can also refer to the styles in which the students learn and

the methods that teachers can use to educate them (Bennet, Malton, & Kervin, 2008; Helsper & Eynon, 2009).

Heritage: The Living History

Living history refers to places, objects, or people that are historically significant because of location, past or historical events, or lived experience (Mayrose, 2012; Luckhardt, 2014). Historical heritage sites in Canada can incorporate Aboriginal locations and knowledge, colonial history, or Canadian history. The reason they are called *living history* is because the public has a present and vested interest in exploring, utilising, or listening to these stories because they have a significant impact. This impact can be in the form of fostering knowledge, nostalgia, tourism, or simple curiosity. The heritage of 'living history' is important because it creates a connection with the learner who can relate to the history they are experiencing, and see it as impactful in their lives. The researcher had a chance to experience a Canadian Railway heritage site firsthand, and to witness the impact of living history and the connections it made with learners of all ages and backgrounds, including both high school and university students.

The 2141 Spirit of Kamloops is a 105-year-old steam locomotive that was built in 1912 in Kingston, Ontario. Over time, it moved towards British Columbia, eventually retiring to Riverside park in Kamloops BC as a display for over 30 years. In the early 1990s, volunteers banded together to restore the engine. For over eight years, a group of volunteer men and women worked to restore the 2141 to operating status. Following these restorations, it began to take guests on hour-long tours of the Kamloops railway area. The connection the 2141 creates for older guests and volunteers is one of nostalgia and memories; these are volunteers who worked on the locomotive during the 1940's and 50's. For the younger generation, the connection is more difficult to describe. Riding on a device that is over 100 years old creates a feeling of wonder and a strong connection with the past. When the guests or volunteers stand where their predecessors once stood, they tend to ask questions like: who were they? What did they do? What were their stories? This reinforces the connection as the volunteers 'take them back in time' with period clothing, music, and events.

The shared experience and relevance strengthens the connection as the guest experiences exactly what a historical passenger would experience. The nostalgia, novelty, and a shared understanding of relevance for the guests, volunteers and the people who have their stories heard after 40 or even 80 years is the basis of this connection. The local Kamloops history is also extolled, along with the impact of the railway on Canada itself. J. Popadynetz, a train manager for the 2141, describes the reason for the connection as: "The connection to the past; everyone has some sort of connection to our past and our train brings it to life. Also, steam locomotives are rare and have a soul to them" (J. Popadynetz, Personal communication, September 7, 2016). Potentially, it is these smaller details, along with the massive impact of the larger picture, that creates and reinforces the connection guests feel for the 2141, Canadian history, and – by extension – history itself. Potentially, if this nostalgia, novelty, and relevance can be reproduced in the classroom, then heritage and history would likely have increased meaning and engagement for students and the larger society. Connecting, engaging, and making history relevant in the classroom is the focus of the study and the focus of teaching.

Purpose of the Study

The main purpose of this study was to assess whether and how AR technology can increase student engagement with content, peers, and educators in history education in universities, and to assess AR learning preferences.

Summary

The problem area focused on was increasing student engagement with historical content, peers, and educators in the university history classroom. The researcher conducted a literature review on current educational methods, educational technology, engagement in classrooms, AR, and current curricula in addition to two research studies in history that used AR curricula to understand the current gaps in research and opportunities for expansion. This study created an immersive historical environment and modular curriculum to study AR's applications in education, wherein technology has been reported to engage students and help them achieve higher success in history courses (Schrier, 2005).

Concerning the problem of disinterest in history, students may not fully understand the impact of history on modern society; they may be subject to socially constructed viewpoints on history instruction, or uninterested in the topic itself. History education along with other subjects such as the sciences, business, and law, is currently incorporating educational technology. This could be enhanced by encouraging use of current methods along with an umbrella framework of modern pedagogical, social, technological, and contextual understanding (Egan, 1978; Freire, 1970/2005; Prensky, 2014). Learning allows the student to study the past and prepare for the future by learning from the mistakes of previous civilizations. Thus, the researcher proposes a future history education based on multi-modal, reality-orientated augmentation approaches to teaching. This encompasses gamification, AR curricula, AR based lessons, Neomillennial teaching styles, interactive campus learning, and city-wide historical investigations, along with gender and social equity in learning.

Chapter 2
Literature Review

A summary of research on AR is presented with a focus on five overarching themes, including: history instruction, learner engagement, general educational technology, AR, and a potential AR curriculum along with two major studies on AR and education. This literature review and study focused on increasing engagement and identifying AR learning preferences.

History Instruction

Educating students in history can be a challenge for instructors in the classroom. The subject encompasses historical literature, persons, and events, and requires a wide range of skills to effectively analyze and understand its implications across a wide range of cultures, societies, and civilizations (Seixas, 2000). Furthermore, history textbooks contain a great deal of text interspersed with pictures that do not illuminate the subject to the degree desired by students (Luckhardt, 2014). Because of this, students and educators may disengage from the subject matter, which can lead to a decrease in positive learning outcomes (Egan & Judson, 2009). As reported by Goodin (2012), current technology can provide access to more varied sources and thus make students more discerning holders of information. Furthermore, Goodin's experimental study (2012) revealed that test scores measurably increased and student behavior was more animated and engaged when using technology.

History education in universities can be seen as similar to the myth of Icarus and Daedalus, however flipped on its head. Many teachers and students are Daedalus, flying far below the clouds, keeping themselves in familiar sight of lectures and tests, textbooks, and methods. Other teachers and students are willful Icarus, flying above the clouds and closer to the sun, able to enact new methods and new technologies and connecting with the contemporary world. These teachers make use of PowerPoints, Moodle, experiential learning, social media, and other educational technologies. This analogy is echoed in part by Prensky (2014) who calls for not only modern 21st century methods and proxies to be let go, but to find the core of modern education that speaks to the Neomillennial students (Dede, 2005; Dieterle, Dede, & Schrier, 2007). However, this call must be tempered with

empirical research that goes beyond the definition of age (Bennet, Malton, & Kervin, 2008; Helsper & Eynon, 2009).

A meta-analysis conducted by Karich, Burns, and Maki (2014) found:

> The components of learner control within educational technology and found mostly negligible effects on student outcome measures. Although overall effects of including learner control within educational technology produced near zero effects, some variables contributed to higher student outcomes (p. 406).

This effect size was small, and the control that learners had over educational technology was too small to affect an increase on their outcomes. This means that students control of educational technology appeared to be neutral based on this study. While the reported effects may be negligible, history educators strive to bring a variety of methods to engage learners in historically relevant topics to teach critical thought and enhance the historical literacy skills of the students. These can be augmented with educational technology to improve reader response (Cheung & Slavin, 2012) and computer-assisted-learning (CAL) to improve workflow (Açikalin, 2010).

Luckhardt (2014) noted that developing historical literacy is difficult and educators often use primary sources to teach historical consciousness, which in effect creates a student who is aware of the effects of history and the criticality of understanding. Additionally, using online sources as a narrative in a native environment, the digital online word, and providing a foundation for discussion between students using social media would enhance feedback (Luckhardt, 2014). These primary sources may be contextually unsuited for modern students facing contemporary issues if they are not provided a connection to modernity. This contextual relevance was explained by Sebbowa, Ng'ambi & Brown (2014) whose research found that history content may not be relevant to modern students as they cannot relate it to their modern lives. This relation appears to be needed if students are to see history as relevant (Sebbowa, Ng'ambi & Brown, 2014).

Rethinking critical pedagogy, curriculum, and technology. As civilizations rose and fell, the instruction and the relevance of learning history has changed from a general

interpretation with the victor being the writer to critical thought and interpretation (Seixas & Peck, 2004). Savich (2009) stated, "An important element of getting students to connect or identify with a historical event or issue is by making it relevant and personal to them. In this way, there is engagement and connectedness to the issue" (p. 6). How can modern students be interested by events in the past that seemingly had little or no effect on their current lives?

Sebbowa1, Ng'ambi and Brown (2014) stated that "history education is becoming dangerously obsolete as it does not relate to the contemporary needs of 21st century learners, who often find history useless and irrelevant to their present situation" (p. 24). Savich (2009), Seixas (1999), and Vansledright (2004) tackled this problem in similar ways. Critical thought processes are espoused by Savich (2009), as a way for students to become historically literate. Furthermore, they can "evaluate, assess, analyze, conceptualize, and judge what is presented as information or facts. Critical thinking skills are important in a democracy where citizens need to be informed in order to make judgments and decisions" (Savich, 2009, p. 12). Vansledright (2004) described the methods used by two separate teachers: both are effective, one lectures from a planned curriculum as described by (Aoki 1986/1991) while the other exists in a lived curriculum. Vandelsright (2004) stated that "The knowledge history teachers need to possess in order to significantly deepen their students' historical understandings, as complex, multivalenced, and socioculturally diverse as those might be" (p. 2). Teachers must be knowledgeable about their subject to a high degree. However, this does not guarantee that students will be interested or see the course as relevant. Both teachers described in Vansledright's (2004) book had full classes but one group scored higher on SATs. He went on to describe the potentials of investigative history, stating that while uncommon, research indicated "that it shapes and cultivates deeper historical understandings of the sort epitomized by the experts than do our more common and traditional ways of teaching history in school" (p. 2).

This raises questions about how history is taught and the ways both scholars and teachers construct history. When creating history curricula for student consumption, teachers, and scholars, according to Seixas (1999), should work together. He notes that

"The separation of 'content' and 'method' and the distance between historians and teachers were thus closely connected problems" (p .1). This can create further problems when delivering knowledge to students as scholars and teachers can have different interpretations. This separation of teacher and scholar can only have negative repercussions on the student who is developing critical history skills, referred to as "learning to do the discipline" by Seixas (1999). Furthermore, "Hertzberg, Dewey, and Shulman remind us that content separated from pedagogy is an incomplete metaphor for knowledge. Yet the dichotomous formulation has tremendous staying power" (Seixas, 1999, p. 319). Thus, both content and pedagogy are potentially best used together.

Even though history teachers do use educational technology in their classrooms, the level of it depends on the teacher, classroom, and students. Most commonly used are Moodle and PowerPoint, though some teachers experiment with new educational technology and methods. Morgan (2013) used Second Life, an online virtual world, and asked students to use the program in research projects. He found that there was an effective use for Second Life in history educational methods, and encouraged the use of virtual technologies. Other educators used television, such as Putman (2013), who utilized Star Trek to teach World War II and contextualize history, helped students overcome bias and stereotypes. Finally, educators have used social media and experiential learning to engage students and update older curricula for current and future students (Reyerson, Mummey, & Higdon, 2011).

The relevance and implications of history instruction. History has broad implications in a wide range of fields. Educating a student in history can create a person who is historically aware and capable of applying critical thought and analysis to the modern world (Egan & Judson, 2009). Furthermore, this 'historical consciousness' (Luckhardt, 2014) is critical in understanding major-scale social, political and national interactions. Fostering learner engagement in the subject is also essential.

There are many ways of teaching history, from straight lecturing, to inquiry, investigation, using educational technology, and experiential learning. The challenge for scholars and teachers is to find the one that works in each individual moment in the

classroom. This provided an adaptive learning experience for students who are themselves constantly changing and engaging in response to the wider world.

Learner Engagement

Learner engagement is the cornerstone of an educator's classroom, and how much the learners are engaged can be thought of generally as a function of how well they do in their course. As Roorda, Helma, Spilt, and Oort, (2011) stated in their meta-analytic approach to teacher-student relationships: "The correlations between the combined person-centred teacher variables, on one hand, and participation, positive motivation, and the composite of all cognitive student outcomes, on the other, ranged from medium to large. The influence of teacher behaviours has also been shown in the research area of instructional communication" (p. 494). The meta-analysis addressed positive and negative factors of TSR, attempting to define and explain the relationships between them, with a focus on previous research (Roorda, Helma, Spilt & Oort, 2011). Educational technology was not mentioned in the study, but other research on it found a positive effect on learner engagement (Açikalin, 2010; Goodin, 2012). Prensky (2014) stated, "As the digital-aged learners of today prepare for their post-classroom lives, educational experiences within classrooms and outside of schools should reflect advances both in interactive media and in the learning sciences" (p. 37).

Interactive media is continually advancing, and the interactivity presented to students is much more the norm as "The current generation of college students (ages 18-22) tend to be experiential learners, they prefer to learn by doing, as opposed to learning by listening" (Oblinger, 2004, p. 2). It is estimated that by the time an individual is 21 years old, they will have spent 5,000 hours reading, 10,000 hours playing video games, and 10,000 hours on the cell phone (Prensky, 2001, p. 3). Furthermore, Hattie (2008) stated in a meta-analytic review that inquiry-based learning had a negative impact on the student and their engagement. Therefore, it can be postulated that if inquiry-based learning is ineffective for engagement, are there areas where it does work in a positive manner?

The relevance of this is clear: education is potentially more effective when based on concepts that work, and those concepts are constantly in flux, changing to reflect society

and culture. Jardine (2023) stated, "The mindfulness of inquiry often requires bloody-mindedness and refusing to expend ourselves in the ever-accelerating rush of empty time that is deliberately designed to never be satisfied and to produce in us a cynicism about any viable alternative" (p. 24). Thus, if concepts such as learner engagement are so fragile, how can we as educators and scholars make learning and the acquisition of knowledge useful to students? hooks (1994), in her work *Teaching to Transgress*, described teaching as a path to freedom and to work; not to merely share information, but to share in the growth of the students. Furthermore, Freire (1970) called for a revolution in education. A change from the widely-sanctioned methods that we use today, to return to a human centered approach. "The 'humanism' of the banking approach masks the effort to turn women and men into automatons—the very negation of their ontological vocation to be more fully human." (p. 74). Liberation has many definitions, in the context of education as hooks and Freire espouse, it means teaching in innovative ways that allow creativity to flourish.

Perhaps, engagement is a more fluid concept than has been historically understood. As both Prensky (2014) and Bassendowski and Petrucka (20013) mentioned, our methods must be updated to reflect the changes in our society which are in constant flux.

Relevance and implications of learner engagement. Learner engagement is critical to the student and the history classroom: it can transform a boring class with old textbooks and tired students into an interactive classroom, and could become another method in increasing learner engagement by using educational technologies (Bassendowski & Petrucka, 2013; Bernard, Borokhovski, Schmid, Tamim, 2014; Karich, Burns, & Maki, 2014; Mayrose, 2012; Zhang, 2014).

Educational Technology

Educational technology is an emerging field in the last three decades that focuses on using technology from commercial and government applications in the field of education (Papert, 1980). The focus is on enhancing student engagement, knowledge acquisition, digital literacy, and global awareness, among other skills (Wilson, Wright, Inman & Matherson, 2011). However, "The image of students passively absorbing information from an educator who is lecturing from behind a podium does not reflect the current

scope and dimension of higher education" (Bassendowski & Petrucka, 2013, p. 665). Technology has rapidly increased and educational facilities, teachers, and pedagogy should follow suit.

Goodin (2012) reported that the goal of all social studies educators – and arguably all educators – is to bring multiple resources to the classroom. Mayfield (2014) noted that electronic technologies are increasingly influencing how students learn about the world. Tamim, Bernard, Borokhovski, Abrami and Schmid (2011) found an effect size of 0.35 on the positive effects of computers in education in an exhaustive, second order meta-analysis of educational technology. However, despite some promising research (Açikalin, 2011; Goodin, 2012; Machin, McNally, & Silva, 2007) the increased prevalence and use of computers in schools yielded mixed results (Karich, Burns, & Maki, 2014). Thus, perhaps different kinds of technologies are needed.

Educational technology includes many types of technology, including virtual environments using special glasses and software haptics which use the sensation of touch much like the virtual keyboard on a cellphone, and popular software such as Microsoft Office (Luckhardt, 2012; Mayfield, 2012; Minogue & Jones, 2006; Taylor, 2016). Furthermore, web-based applications such as social networking, online discussion boards, Moodle and even games are included (Junco & Cole-Avent, 2008; Luckhardt, 2014; Uricchio, 2005). Video games, even though the contents are often fictional, and their learning impact is sill being debated, can be an asset for education. Meier, a key developer of historically-oriented games, put it best: "We're not trying to duplicate history. We're trying to provide you with the tools, the elements of history and let you see how it would work if you took over" (cited in Uricchio, 2005, p. 329). This is the concept of simulation history.

Murray, Giesbrecht, and Mosonyi (2011) noted that online courses had effects on the educator and the student that increased engagement and teaching enquiry-based learning styles. Furthermore, teaching faculty and staff integrated educational technology, which was a logistical challenge that should also be addressed (Mirriahi, Vaid, Burns, 2015). Lastly, the pedagogy and understanding around educational technology as expressed by Lee et al. (2013), who examined effects of teaching and learning on students, found a

moderate positive effect size that could be advanced to match educational technology along with continuing education for teachers (Bernard, Borokhovski, Schmid, Tamim, & Abrami, 2014; Chai, Koh & Tsai, 2013; Mirriahi, Vaid, Burns, 2015; Murry, Giesbrecht, & Mosonyi 2011).

Relevance and implications of educational technology. Research found that educational technology can have a positive and a negative impact on learner engagement (Goodin, 2011; Roorda, 2011; Tamim, Bernard, Borokhovski, Abrami & Schmid, 2011), and can create engaged students as well as challenges for teachers (Mirriahi et al., 2015). Distinguishing between effective and ineffective technologies may be difficult for the practitioner. Some technologies that are tried and true such as PowerPoint may not engage the student to the desired degree while newer technologies may have both technological and informational issues. These technological issues can include bugs in the programming, and the application failing to work as expected when used in a classroom context. Furthermore, students may not be aware of the technology, how it fits into their lives, and how to use it effectively. Finally, the educator may also be minimally experienced with the educational technology they desire to use, and it could potentially increase the difficulty of using it in the classroom. This study also identified an emerging technology that may be useful for education: touchable holography, where lasers create a touchable image in the air in front of the user (Hoshi, Takahashi, Shinoda, & Nakatsuma, 2009).

Augmented Reality Technology

Virtual reality has the ability to send a person into a digital world, pulling the user from the physical surroundings. However, AR does the opposite and brings the digital world to the user's reality and physical space by super-imposing information technology on everything the user sees (Taylor, 2016). AR, or Terminator Vision (see Figure 1) as it is colloquially known, is generally described as hidden information overlaid on the world in front of the user.

Figure 1. Augmented Reality was made popular by the Terminator movies as seen above (Cameron, Hurd, Schwarzenegger, Hamilton, & Biehn, 1984).

However, unlike a Heads-Up Display (HUD) or Virtual Reality (VR) device, the AR user remains in the physical space with the information overlay adapting to their movements without a cumbersome Virtual Reality headset (Cassella, 2009; Mann & Michael, 2013).

AR can be thought of in its simplest terms from the Milgram-Kishino Reality Virtuality Continuum (1994) (see Figure 2). On the chart at the left is the real environment as a human experiences it without any technological aid. Moving towards the right, the user experiences increasing integration of digital technology or stimulation within the real environment.

Figure 2. Reality Virtuality Continuum. This shows the various realities that a human can experience. On the left is normal reality, while on the right is a virtual reality as made by technology. Augmented reality is closer to normal than virtual reality (Milgram, Takemura, Utsumi, & Kishino, 1994).

This introduction of hidden or new information can increase the user's knowledge of the local area or be used for direction finding. Furthermore, AR has been used in medical and engineering applications to general success (Martín-Gutiérrez, Fabiani, Benesova, Meneses, & Mora, 2015). AR can be used with a phone, tablet, eyewear, or separate device that responds to either GPS data, or with photo triggers prompting overlaid information. Photo triggers are any area, picture, or camera recognizable medium that triggers the AR application. This technology can be used to recreate historical information locally without having to travel to the physical area. It can also have a host of other uses including navigation in a city, displaying information, and even dating as the short film *Sight* depicts (see Figures 3 & 4).

Figure 3. Augmented Reality on a cell phone. This image shows a potential demonstration of what augmented reality could accomplish by highlighting various places of interest to the user (Real AR, n.d).

Figure 4. The short film Sight posits AR technology for numerous applications. Here it is being used as part of a dating or 'wingman' app (Lazo, May-Raz, Golad, & Aroshas, 2016).

Educational technology has seen incredible gains and adoption among educators within the past 10 years (Goodin, 2012). This includes PowerPoints and whiteboards, as well as online and technological learning applications aimed at reducing and simplifying the physical curriculum that teachers use. Educators are seen as guides rather than founts of information as students are able to call up information on nearly any subject within seconds (Egan & Judson, 2009). This change calls for teachers to modify and adapt to the future of their students and technology (Egan & Judson, 2009; Lee et al., 2013; Smith, 1996/2000). AR activities could provide the perfect solution for a technological curriculum.

Augmented reality, gamification, and immersion. Gamification of education has been used increasingly as video games become more prevalent in society. Nearly all games that are first-person shooters (FPS) or first person in some degree have what is called a HUD or Heads-Up-Display, most commonly seen by the public in aircraft cockpits. The HUD displays information that is relevant to the user or player and sometimes incorporates environmental parsing, meaning it updates in response to the changing environment around the player. However, this HUD is generally an AR display that is tethered to either a surface such as a table (see Figure 5), glasses, a phone, a transparent LCD computer display, or eventually contact lenses. According to Squire and Klopfer (2007), “Playing the game in "real" space also triggered students' preexisting knowledge, suggesting that a powerful potential of augmented reality simulation games can be in their ability to connect academic content and practices with students' physical, lived worlds” (p. 1). This suggests that games have found a medium to display information and knowledge to gamers, that education can be adapted for students, many of whom play video games.

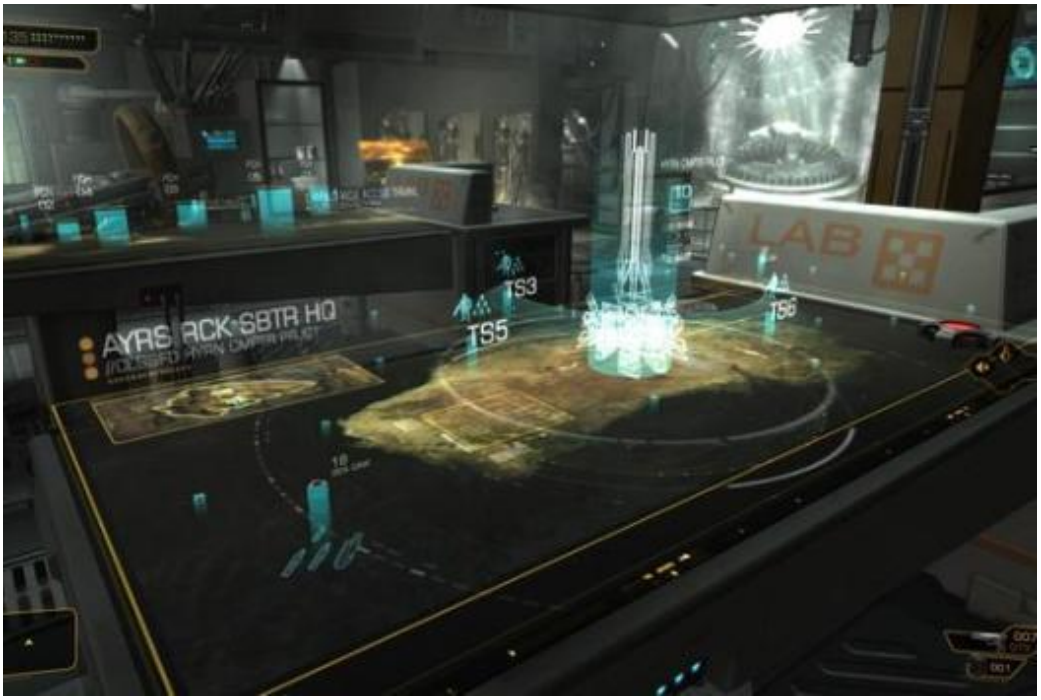

Figure 5. The video game Deus Ex Human Revolution displays AR information on tables for the player character, a mechanically augmented human. This could potentially be used in education to display maps or other large features such as historical buildings (Square Enix/Eidos Montreal, 2013)

An example is Dice's Battlefield 4 (see Figure 6). The player is provided information onscreen through an unmentioned AR display which is transparent, allowing the user to see the physical world and react accordingly to changing situations.

Figure 6. Dice's Battlefield 4. The player has an AR display that provides battlefield information similar in part to what real world militaries are developing (Dice/ EA Dice, 2014).

A more extreme example is Tom Clancy's Future Soldier (see Figure 7) which, while third person, displays AR information seamlessly with the game environment. For example, when the player looks to the sky, they see weather and temperature information, such as an incoming sandstorm.

Figure 7. Tom Clancy's Future Soldier uses a more visible method of fictional CrossCom '3.0' AR technology. Here AR is displayed on nearly every surface providing critical battlefield information (Ubisoft/Red Storm Entertainment, 2012).

This example could be translated to real life, wherein the user would have a seamless display of information mixed with the real world. Science fiction, games, and movies have used virtual reality and AR long before they were popular subjects in mainstream media. It is also interesting to note that militaries are actively developing this technology for enhanced situational awareness for their soldiers (Livingston et al., 2011). However, games remain the most popular venue for this technology.

Educators have employed games for teaching. Gamifying a subject can be simple or complex, depending on the subject and how far the instructor wants to go. According to Deterding, Dixon, Khaled, and Nacke (2011):

> Gamification refers to: the use (rather than the extension) of; design (rather than game-based technology or other game related practices); elements (rather than full-fledged games) characteristic for games (rather than play or playfulness); in non-game contexts (regardless of specific usage intentions, contexts, or media of implementation) (p. 12).

AR lends itself particularly well to gamification as shown by the immense popularity of Pokémon GO (Cabero, & Barroso, 2016; Hammady, Ma, & Temple, 2016). Agreeing with the above definition of gamification, da Rocha Seixas, Gomes, and de Melo (2016) found that there has been an increase in the use of gamification for non-game applications that also enabled students to receive instant feedback. It enabled student gratification and acknowledgement on tasks completed. This is significant because their findings highlighted that achievements badges had positive effects on student engagement in elementary schools, (da Rocha Seixas, Gomes, & de Melo, 2016). Their work also agreed with McGonigal's "Reality is Broken" (2011), where the use of games need not be solely focused on entertainment, but also used for building life skills. Research by Buckley and Doyle (2016) supported this finding, though they described gamification in education as 'cautiously optimistic' and called for more research. They noted that personality traits influence positive impressions of gamification (Buckley & Doyle, 2016).

Stott and Neustaedter (2013) referred to gamification as "the application of game dynamics, mechanics, and frameworks into non-game settings" (p. 1), and found that four gamification concepts are successful then applied to educational environments. These include "freedom to fail, rapid feedback, progression and storytelling" (Stott and Neustaedter, 2013, p. 1). Furthermore, similar to other researchers, they espouse a nuanced approach to using gamification in education, stating that there appears to be no one size fits all approach (p. 1). Finally, according to research by Sailer, Hense, Mayr, and Mandl (2017), certain aspects of gamification, including "badges, leaderboards, and performance graphs all positively effect competency but need satisfaction and task meaningfulness," while "avatars, meaningful stories and teammates effect social relatedness" (p. 1). Furthermore, similar to previous research (Buckley & Doyle, 2016; da

Rocha Seixas, Gomes, & de Melo, 2016; Stott and Neustaedter, 2013) they found that gamification can be a powerful resource to address motivational problems (Sailer, Hense, Mayr, & Mandl, 2017). However, they stated dissimilarly that "gamification is not effective per say but that specific game design elements have specific psychological effects" (p. 1). According to Blessinger and Wankel (2013):

> If designed properly and integrated into the course in a purposeful manner, immersive technologies can provide today's learners with a viable means to further enhance their learning experience, especially since todays learners are increasingly accustomed to interfacing with digital, virtual realities (p. 6).

They also listed several application benefits according to a majority of scholars of the learner centered approach. This included inter and intra group dialogue, belonging, mediation of learning tasks, multi-perspective development, and personalized learning.

Taking the preceding research and literature into account, the researcher determined that the four concepts by Stott and Neustaedter (2013), "freedom to fail, rapid feedback, progression and storytelling" (p. 1.), represent a starting point when designing a gamified curriculum. Furthermore, a nuanced approach is desired as interpretations of the gamified process can be highly subjective based upon personality (Buckley & Doyle, 2016). However, the generalized definition as espoused by Deterding, Dixon, Khaled, Nacke (2011) remains true. Finally relating the gamified curriculum to life skills or determining their usefulness as described by McGonigal (2011) will be critical to the student in creating achievement and engagement. Thus, creating a curriculum is a complex process that must cater to many different students whilst not losing sight of the educational objectives. Here, teachers are the critical lynchpins in the process of student engagement (da Rocha Seixas, Gomes, and de Melo, 2016; Gapp & Fisher, 2012) and their participation must be emphasized when enacting the curriculum.

Augmented Reality as a Curriculum

William Doll (1993) stated, "The heart of the curriculum process calls for adding continuously to [these] connections [between students and teachers], making the overall system deeper, richer, darker" (p. 289). Curriculum can be defined as the what, how and

why of educational information (Egan 1979). Furthermore, Egan (1979) and Egan and Judson (2009) stated that a problem exists when focusing on the basic question of what curriculum is. Egan (1978, 1979) described the evolution of the problem along with several examples and stated that the reason the problem exists is because educators decided to ask the questions in the first place. While much discussion about these areas has occurred, especially in the last two decades, the myriad of solutions and answers to the *problem* of curriculum can be described in a humorous and accurate narrative from Boswell (1950) sixty years previous:

> Boswell, searching around for a topic of discussion one Tuesday morning, asked Dr. Johnson what was the best thing to teach children first. Johnson replied: "There is no matter what you teach them first, any more than what leg you shall put in your breeches first. Sir, you may stand disputing which is best to put in first, but in the meantime your backside is bare. Sir, while you stand considering which of two things you should teach your child first, another boy has learnt 'em both" (p. 323).

This neatly sums up the confusion that surrounds curriculum as described by Egan (1978) and Egan and Judson (2009). However, despite the general confusion, scholars have emerged (Stenhouse 1975; Smith, 1996/2000) who advocate for a revised and less confusing method of curriculum delivery.

The what. The AR Curriculum could teach British Columbia History 12 with many the major focuses that the BC IRP (2016) outlines or that are included in university curricula as per the individual educator (Chambers, 2003; Pinar, 2003). The only major difference is that assignments and classroom presentations would be shifted from traditional methods to using AR in an experimental manner as shown by several scholars (Mann & Michael 2013; Papagiannis, 2014). Furthermore, the what of the curriculum as Egan and Judson (2009) and Smith (1996/2000) describe is culture based, and is open to interpretation and refinement. Wolk (2003) describes four questions that could potentially affect the adaption of AR into the curriculum: (1) The authenticity of the AR, tasks, tools, and resources, (2) The social learning and cooperation; (3) Self-guided, but

mentored discovery of history; and (4) Reflective practice and engagement. Thus, the curriculum is defined as what is needed by the students at that point in time and what will create students that define the culture.

The why. The why can be described as one of the most important pieces of a curriculum. Why teach the subject at all? Will it be relevant, and will it help students become productive members of society? Dewey (1897) stated, "I believe that this educational process has two sides - one psychological and one sociological; and that neither can be subordinated to the other or neglected without evil results following." AR has the potential to link students in a similar and even more evocative way than social media has done in the past decade. As expressed by several scholars and their research (Billinghurst, Weghorst & Furness III, 1998; Mann & Michael, 2013), AR technology is rapidly advancing and the prospects of incorporating it into everyday life are becoming commonplace. Furthermore, as an interactive teaching method that requires no new technology or increased cost, it is being actively considered for STEM programs and medical applications. However, newspapers and scholarly articles (Cassella, 2009; Papagiannis, 2014) have reported that teachers who have used AR to teach or create historical spaces have seen a general increase in the engagement and retention of information by their students. Therefore, it can be postulated that AR has the potential to become a new media platform for exploring history in a manner that students are familiar with from the big screen and video games (Yuen, Yaoyuneyong, & Johnson, 2011). However, without further research, this can only be taken as conjecture.

The how. Egan (1978) described a general confusion about curriculum creation and education. To supersede and rise above confusion, several interested groups would collaboratively design an AR curriculum. The curriculum would teach the 2016 B.C. history curriculum as outlined in the British Columbia Ministry of Education IRP, 2016 (British Columbia Ministry of Education, 2016). The educational outcomes for History 12 are stated as follows:

> A1: analyse primary and secondary sources (historical evidence) with reference to reliability, bias, and point of view, corroborating and conflicting evidence.

> A2: assess significant historical events in relation to social, political, economic, technological, cultural, and geographic factors.
>
> A3: demonstrate historical empathy (British Columbia Ministry of Education, 2006).

The only notable difference would be that, instead of only essays, multimedia and AR would also be used as methods for assessment creation. For instance, a student may be tasked with creating an interactive presentation that outlines Roman Architecture; the presentation would contain text and video, and the accuracy of the historical information could be judged similarly to that of a traditional essay. The free applications ARToolkit and Aurasma could be easily used by the students.

This curriculum is designed to encapsulate Egan (1979) and incorporate a backwards design to benefit the students to the greatest degree possible (Wiggins & McTighe, 2011). Finally, the theory closes with Stenhouse (1974) who developed a pragmatic approach to curriculum that was the basis for the praxis approach suggested by Grundy (1978). This praxis approach is the selected method that the Augmented Curriculum would use because it caters to the needs of the students and allows them to ask questions to develop a greater and more inclusive understanding of history (Smith, 1999/2011). Finally, as the subject of history lends itself to critical thought, the praxis approach could be a strong method to lead the students towards an understanding of the larger picture. Stenhouse (1974) described the objective-based model as flawed, and the objective based model for history education was found to be lacking:

> I believe there is a tendency, recurrent enough to suggest that it may be endemic in the approach, for academics in education to use the objectives model as a stick with which to beat teachers. 'What are your objectives?' is more often asked in a tone of challenge than one of interested and helpful inquiry. The demand for objectives is a demand for justification rather than a description of ends… It is not about curriculum design, but rather an expression of irritation in the problems of accountability in education (Stenhouse 1974, p. 77).

Stenhouse (1974) described education as needing to account for why and how it is doing, creating, and teaching curriculum.

Potential classroom activities. Developing AR for a history classroom would be accomplished in several steps after choosing the application, content, and initial setup. Separating students into small research groups that would allow for collaborative exploration of specific historical topics. Thus, each group would be tasked with teaching parts of the curriculum to other groups. The goal of the class activity would be to create content that to be delivered by AR applications. The proposed research groups would then begin the activity by searching the web for content pertaining to the historical topics they selected at the beginning or in the previous class. Students could be asked any number of significant inquires, for example: to identify similarities and differences across historical artifacts and explain how these evolved from the past to the present time period.

The role of the educator would be to facilitate the search for information, assist students in performing tasks if problems arise, and act as a sounding board for questions. Potential questions pertaining to historical artifacts are displayed below.

- What is the name of the historical artifact? Does its modern name differ?
- What is the use of the historical artifact? Religious? Cultural?
- How was the historical artifact made, what particular tools?
- Where is the historical artifact located; is its location historically important?

Students would discuss with their groups to formulate answers, and then share the results of their research. The teacher could provide grids to fill out, which would then be scanned and digitized as the information would later serve as the content of the AR applications. The creation of AR occurs later in the activity depending on the grade level of students, the availability of computers, and the time requirements of the class. The task is designed to engage students in historical content: their efforts would result in a concrete, real-world product that could be downloaded and viewed by the population outside the classroom. Several AR toolkits and Software Development Kits (SDKs) have been developed for beginners and serve to facilitate the process of creating an application.

Two Examples of Augmented Reality Curricula

Two AR curricula and experiments will be examined to assess their impact on student engagement and best practices, and assist in creating the researchers experimental study. Mad City Mysteries was chosen because it provided a framework for the researcher to follow in creating the experiment. Mad City Mysteries included fictional characters for the students to interact with, a focus question, and the task of gathering evidence to identify a murderer, which were deemed useful in gathering data on engagement. Reliving the Revolution was chosen because it adopted a focus on historical environments, placing the user in the role of a historian, interacting with virtual historical figures and collaborating to answer a multifaceted question.

Mad City Mysteries.

General summary. Squire and Jan (2007) have developed a location-based AR game using handheld computers to increase scientific argumentation skills among students. They call this an opportunity to create a 'post-progressive' pedagogy where students are immersed in scientific inquiry and discourse (Squire & Jan, 2007). They asked whether AR and handheld devices could be used to engage students on scientific thinking, the impact of role playing, and the role of the physical environment. "We argue that specific game features scaffold this thinking process, creating supports for student thinking non-existent in most inquiry-based learning environments" (Squire & Jan, 2007).

The game takes place at the University of Wisconsin-Madison Campus and is described as follows:

> Ivan Illyich is dead. Police claimed that he drowned while fishing by the south shore of Lake Mendota. Between January and the time of his death, Ivan put on 25 pounds and started drinking heavily. His health condition had deteriorated considerably. As one of his friends, your task is to investigate the case with two of your best friends. It is your duty to present a clear picture about the causes and effects of these to the public (Squire & Jan, 2007).

The game takes roughly 90 minutes to complete and students were included in a briefing, game play and debriefing. Students are tasked with interviewing virtual characters, gathering quantitative data samples, and examining government documents to

piece together an explanation of the murder. Student players work in teams that may or may not compete with other teams, depending on the teacher's preferences (Squire & Jan, 2007).

Gameplay for the student players requires them to:

> Observe phenomena in their environment and tie them to underlying scientific processes and phenomena, (2) ask questions about the human and environmental effects of human processes in the environment; (3) engage in scientific argumentation forming hypotheses, refining them based on evidence and discussing and arguing rationale in order to develop theory; and (4) develop conceptual understandings of geochemical water cycles, specifically, how chemicals move through the water system (Squire & Jan, 2007).

They argued that the students, having played the game using AR games on handheld computers, were an exciting new pedagogical model for developing students' scientific literacy, particularly their argumentation skills. Playing AR games immersed learners in a kind of scientific argumentation that is purportedly difficult to achieve and yet desired by science educators as a primary goal of science education (Squire and Jan, 2007). They also reported that, similar to a constructivist style, a game-based approach involves a new orientation to learning for students, teachers, and researchers. Furthermore, they reported that teachers reported increased engagement among their students for science, inquiry, and in their local communities as a major and worthwhile outcome of this study, which stands in stark contrast to the current rhetoric of accountability (Squire & Jan, 2007).

Breaking it down. Squire and Jan (2007) faced several problems and challenges in implementing Mad City Mysteries. The participants were a group of elementary school students, a middle school group and two high school groups of lesser numbers than the first. Squire and Jan (2007) designed and adopted an open, problem-based learning style with multiple causal argumentations and approaches. This style was adopted because they wanted to have a game without a single answer approach as a more robust model of scientific inquiry. Additionally, the location and engagement of the students needed to be carefully selected to hold scientific inquiry for the environmental watershed. They acknowledged that the game is a short-term learning device. Furthermore, students are not developing their own questions or lines of inquiry due to 'black boxing' for question

analysis. They also faced a lack of pre-post data on the student performance which would have been useful for assessing broader student learning. Effective assessment generation was also a challenge in yielding valid interpretations on student learning. A final challenge Squire and Jan (2007) faced was the active participation the investigators played with the game. The younger participants needed supervision and they acknowledged this could play a part in the participation of schools using the same game-based approach.

Implications. The implications of Mad City Mysteries can be drawn from the research. Squire and Jan (2007) reported that student enthusiasm increased and that student participants gained an appreciation for argumentative science along with role play and inquiry. They reported that location-based AR has the potential to increase student understanding of authentic scientific inquiry and research, (Squire & Jan, 2007). This location-based game could also be aimed at other fields of study including history. It would be able to teach students historical inquiry, rigour, and the critical evaluation of evidence along with collaboration with team members and their virtual partners. Furthermore, this game could be adapted to other locations which would be critical in using location-based games. This adaptation would bring local cultural and historical relevance to participants which, as reported by both Squire and Jan (2007) and Schrier (2005), was critical to their research design.

Reliving the Revolution

General summary. Schrier (2005) created a location-based AR game for history students at MIT. This game was designed around the historical Battle of Lexington and was used to simulate the activities of a historian for the participants, including evidence collection and interpretation. Participants were to interact with virtual historical figures and collaboratively evaluate the evidence to prove who fired the first shot. The results of Schrier's (2005) work showed that there was a potential for AR games to enhance the learning of "(1) historical name, places, and themes; (2) historical methodology and the limits to representations of the past; and (3) alternative perspectives and challenges to "master" historical interpretations" (p. 1). Furthermore, they stated that it could create an authentic 'practice field', increase potential for collaboration among students, express

identities through role playing and consider interactions between the real and virtual world (Schrier, 2005).

Breaking it down. Schrier (2005) created an interactive historical game for students wherein they would act like detectives. They analyzed data presented through historical figures and then, in teams, identified the shooter. This taught evidence analysis and critical history through gamification of history. The evaluation of sources and their interpretation was key in Schrier's work.

Schrier examined the following topics to guide her research:

(1) Understand better the people and leaders involved in the Battle of Lexington and the American Revolution; (2) Become more aware of the social, economic, geographic, and political forces surrounding the Battle of Lexington and the American Revolution; (3) Learn more about a local historic site and how it functioned in the past. Build Knowledge of the Methods and Limitations of History; (4) Question sources and authorial intent of evidence; identify biases in evidence; (5) Create hypotheses, and draw inferences and conclusions based on historical evidence; (6) Consider the limits of historical methods and representations of the past. Confront Multiple Perspectives and Mainstream Interpretations of the Past; (7) Understand and critique master narratives of the Revolutionary War, the Battle of Lexington and history in general; (8) View, seek out, consider, and manage multiple views of the Battle of Lexington and other historic moments, and (9) Reflect on ones' own perspective on the past and recreations of event (Schrier, 2005).

Implications. The implications for Schrier's research (2005) are very similar to those found by Squire and Jan (2007) even though the fields of inquiry are separate. The location-based AR approach allows students to gain a critical cultural and location-based relevance within their local communities. Furthermore, working with a team allows the participants to develop social and team building skills that are in high demand in nearly all sectors of work and research. Finally, developing historical literacy and critical inquiry based on evidence from several virtual historical persons is critical in creating a student who can interpret history based on conflicting evidence (Schrier, 2006).

Relevance and Implications of Augmented Reality in History and Science

AR has the potential to become the next technological leap in education if certain hurdles are overcome (Chen, Liu, Cheng, & Huang, 2017). These hurdles can include cost, area of implementation, teacher and student training, and the technology itself. Is the augmented portion enough to create the suspension of disbelief for the student? While textbooks face increasing costs and drive students to imaginative ways to either save or buy these books, digital and virtual technologies provide new avenues for knowledge acquisition, learning, engagement, and teaching (Weisbaum, 2016). Furthermore, while textbooks offer a liner narrative to the student, AR can offer a nonlinear pathway for the student to observe the past (Schrier, 2005) or create further inquiry (Squire & Jan, 2007). Interestingly, the medical profession has willingly adopted AR and has been using it to teach medical students in a variety of ways. This can range from true AR, to virtual reality, or using online platforms such as Second Life or Rocketmoon (Milgram, Takemura, Utsumi, & Kishino, 1994). As described by Hansen (2008), 3D Virtual environments have the potential in medical professions to encourage active learning that is dissimilar to the static classroom lecture. Furthermore, the use of virtual characters to engage and increase engagement among students, rather than being written by the researchers, can be adapted to use Artificial Intelligence or AI similar to an AI named Jill Watson that was used in a classroom to teach the creation of AI (Maderer, 2016). Students reported interacting with Jill was normal and she was seen as a person even after she had been revealed as artificial (Maderer, 2016). While some see AI as dangerous, others, such as Stephen Hawking and Elon Musk (AI Open Letter - Future of Life Institute, 2015**)**, see them as a potential benefit (Maderer, 2016). AI has the potential to interact with humans in a virtual world as almost a surrogate human (Maderer, 2016). There are potentials to be explored, including "Educators that see "on-the-horizon technologies" in higher education present an opportunity for today's learners to explore exciting worlds beyond the traditional classroom and are showing an understanding of current students' use of technology" (Hansen, 2008).

The Future of Educational Technology

Holographic technology. The future of AR can be summarized in research conducted by Lee (2013). Lee described the current Virtual Reality trends in society and education while going into length on the development of 3D holographic technology which requires no user-based device. Furthermore, this would provide full user interaction which is integral in learning, including force feedback (Lee, 2013). 3D holographic technology along with AR contacts and increased device processing and rendering power has incredible potential to create new educational frontiers (Sight, 2015).

Augmediated reality. Dr. Steve Mann coined this term which describes the connections between multimedia applications and AR (Mann & Michael, 2013). This Augmediated Reality is similar to the contemporary IoT which describes the ever-increasing connectivity between devices, applications, and their users. Future applications of AR will incorporate this connectivity making the experience between user and technology seamless. This seamless connection is the cornerstone of AR technology providing an immersive interface that the IoT cannot.

Science fiction to science fact. Technology has progressed at a rapid rate and our predictions for the future have become increasingly correct as our ability to predict becomes enhanced by the technology we develop. The future of education could be a reliance on the extreme connectivity and novel teaching methods that Neomillennial students exemplify, echoing Prensky (2014) and Dede (2005). Santos et al. (2014) conducted a large meta analysis focusing on examining effect size, prototypes, and Augmented Reality Learning Experiences (ARLEs) of AR technology in educational contexts aimed at informing the design of future ARLEs. They examined 87 research articles and looked for user studies and effect sizes. Seven were found to meet the two criteria while 43 only met the criteria for user studies. Santos et al. found a varying effect size from the data studied, however the effect size averaged to 0.56 which is moderate in relation to student performance in the classroom. This effect finding is significant because it correlated multiple AR studies and their effects on the students and found a positive association with this technology. Furthermore, Santos et al. (2014) preformed a qualitative analysis on designs of ARLEs, calling for standard designs for increased testability of effect sizes on student performance. Concluding their findings, Santos, et al.

(2014) described AR as having three inherent advantages: real world annotation, contextual visualization, and vision haptic visualization. These advantages are critical to the development of ARLEs because they are grounded in several theories including multimedia learning, experiential learning, and animate vision theory. Each of these theories can be grounded in AR because AR allows the participants to lean via multimedia, hands on, or animated technology, as well as visuals. Santos et al.'s (2017) meta-study is potentially critical to the future design and standardisation of AR technology in education.

The following table (Table 1) summarizes research and contributions from major studies on AR technology in several contexts.

Table 1.

Researcher's contribution to Augmented Reality

Citation	**Research Focus**	**Contribution to Field**
(Santos et al., 2014)	AR Learning Experiences	Meta-analysis and design for future AR studies
(Chang, Morreale & Medicherla, 2010)	AR and education	AR's applications in educational contexts
(Coffin, Bostandjiev, Ford & Hollerer, 2010)	AR, education, distance learning	AR's effects on distance e-learning
(Dede, 1996)	Technology's effect on learning	AR's effects on distance education
(Jee, Lim, Youn & Lee, 2011)	AR, E-learning, and AR programming	Creation of AR authoring tools
(Billinghurst & Duenser, 2012)	AR and education	Classroom applications for AR
(Billinghurst, 2002)	AR and education	AR's potential for classroom applications
(Shelton, 2002)	AR and education	AR classroom applications
(Wu, Lee, Chang, Liang, 2013)	AR's barriers to education	Current opportunities for AR in education
(Lee, 2012)	AR and education	Training with AR in educational contexts
(Kaufmann, 2003)	AR and educational group work	Group collaboration using AR
(Kesim & Ozarslan, 2012)	AR and education	Current/future state of AR
(Chen, Liu, Cheng & Huang, 2017)	AR and education	Suggestions for future research on AR

(Cheng & Tsai, 2013)	AR and education	Suggestions for future research on AR
(Milgram & Kishino, 1994)	Virtual Reality technology	Classification of virtual reality displays
(Schmid, Bernard, Borokhovski, Tamim, Abrami, Wade, Surkes & Lowerison, 2009)	Technology's effect on educational achievement in higher education	A meta-analysis on educational achievement in relation to technology
(Tamim, Bernard, Borokhovski, Abrami & Schmid, 2011)	Technology's effect on Education	Second-order meta-analysis on technology in education
(Klopfer & Sheldon, 2010)	AR and educational challenges	Challenged for AR in educational contexts
(Bower, Howe, McCredie, Robinson & Grover, 2014)	AR and potential in education	AR's potential for usage in education
(Bacca, Baldiris, Fabregat & Graf, 2014)	AR and education	Review of AR in educational contexts
(Mann & Michael, 2013)	AR and society	AR and wearable media
(Martín-Gutiérrez, Fabiani, Benesova, Meneses, & Mora, 2015)	AR and higher education	AR collaborative learning
(Squire and Klopfer, 2007)	AR and Education	Student-created AR focusing on science fields
(Livingston et al., 2011)	AR and military applications	AR advanced warfighter applications and spatial awareness
(Papagiannis, 2014)	AR, education, and curriculum	AR transitions in technological usage
(Wolk, 2003)	AR and education	Utilising AR for Social Studies
(Billinghurst, Weghorst & Furness III, 1998)	AR technology	AR collaborative networks
(Squire & Jan, 2007)	AR, education, and environmental science	Placing AR within environmental sciences
(Schrier, 2005)	AR, education, and history	Utilizing historical evidence with AR and educational methods

Summary

This review identifies several areas that require further elaboration and study: specific educational technologies and their effects on student to teacher engagement, and critical development of an extensive and comprehensive pedagogy for educational technology that creates an efficient pathway for educators and further research on the effectiveness of learner engagement while using AR. Students are able to access information to a degree unparalleled in the previous decades, and educators have the essential task of

modernizing their educational methodologies (Dede, 2005), pedagogy, technology, and curriculum to match.

> Today's teachers have to learn to communicate in the language and style of their students. This does not mean changing the meaning of what is important, or of good thinking skills. But it does mean going faster, less step-by step, more in parallel, with more random access, among other things (Prensky, 2001 p. 4).

Dede (2005) called for modern teaching methods for Neomillennials, and argued that present methods do not consider changes in technology. Furthermore, he argued that AR and virtual worlds along with wireless technology and immersion can bring a depth to education that is required when teaching Neomillennial students (Dede, 2005). The methods we use to teach students now may not be as effective as they once were. Furthermore Books (2010) stated that "The basic components in the relationship between students and teachers include; individual features, information exchange between the parties and external influences to the relationship." Prensky (2001) also stated, "Our students have changed radically. Today's students are no longer the people our educational system was designed to teach" (p. 1). Thus, the educators and curricula designers must change with them. This should not be a radical change but a more gradual evolution; as technology progresses so should teachers progress their methods.

Research Questions

Based upon the literature review and the existing research, the following research questions were used to guide the study:

1. Will augmented reality historical environments increase engagement with the professor, among students, and with historical content?
2. What historical and augmented reality topics will students or faculty identify as increasing learner engagement?
3. Will Augmented Reality increase the acquisition of knowledge in history classrooms?
4. What barriers will students and educators report on using Augmented Reality in the classroom?

5. What recommendations will participants provide on using augmented reality in the history classroom?

Chapter 3
Research Methodology

The main goal of the research was to identify educational learning preferences and historical teaching methods using AR that increase learner interest in the university history classroom. A mixed-methods approach was used in the study to generate the strongest evidence for any findings; this involved observing and administering a survey during the instructor-led history class and an experimental AR curriculum based off the instructor's chosen topic and focus. During this AR curriculum, a survey was provided, field notes taken, feedback sheets provided, and the researcher asked participants to be involved in a semi-structured interview. The proposed research identified specific educational preferences that were reported to support learner engagement with content, teacher-student engagement, and identify AR curriculum preferences that students use concurrently to increase interest. The identified learning preferences would be used to improve the study and the use of AR technology in education. In addition, the proposed methods were designed to gather the strongest evidence to examine the proposed research questions**.** Semi-structured interviews, a survey, and field notes were used to obtain the strongest data for the research study (Babbie, 2005; Burgess, 1991; Creswell, 1998, 2015; Crocker, Besterman-Dahan, Himmelgreen, Castañeda, Gwede, & Kumar, 2014; Hu, 2009; Meyers, Guarino & Gamst, 2005; Newton, 2010; Norman, 2010; Sanjek, 1990; Savin-Baden & Major, 2013; Webb,1991).

The university where the study took place was in the province of British Columbia, located on unceded lands of the Secwepemc nation. This research project was conducted by one researcher who had been a student at Thompson Rivers University (TRU) for eight years. The student population at TRU is multi-national and multi-cultural, and included a variety of age ranges, genders, faiths, and demographic backgrounds representing the full multi-pluralism of Canada. However, the history class where the study took place was not representative of TRU's multiculturalism. The primary buildings where history courses are taught are older units that have only been partially

updated with technologies such as SMART boards, and that experience frequent technological problems.

Participants experienced a pre-test, post-test design trial. Thus, the class was tested before and after the AR experience. When designing the research, the teacher effect had to be taken into consideration. The teacher effect is when a teacher has a measurable effect on the student's grade or ability in class based on the teacher's ability, engagement with students, and effectiveness of teaching (Nye, Konstantopoulos & Hedges, 2004). The results could vary depending on the teacher's level of engagement with the students. Teachers who already have a high level of student engagement during the study could potentially see a negligible increase in engagement based on the already high engagement. Both the teacher and the students were permitted to withdraw from the study at any time, and participation was not mandatory. The students did not receive marks, nor monetary compensation, and the study findings were not applied to course marks.

Participants

A target group of 19 students in a third-year undergraduate history class and their professor at Thompson Rivers University (TRU) participated in the study. There were eleven females and 7 males with one respondent not reporting gender. The average age of the participants was 20.8 and the standard deviation was 2.2 (see Table 2 for demographic data). The study topic for the AR experience was chosen by the history professor and the AR curriculum was tailored to match. The instructor and students were interviewed after the AR curriculum was completed. The students were in their second, third and fourth years and had been studying in certificate, diploma, and degree programs at TRU. Participants were also sought out that took part in the initial surveys, however, students who did not participate in the survey were not excluded from the study. Although the chosen class did not provide an equal number of male, female, and other-gendered participants, gender, ethnicity, and demographic factors were considered as they may have influenced the experiment.

Table 2.

Participant Demographic Data

Participant	Program	Major	Year	Courses Taken	Age	Gender
1	BA	History	4	NA	24	2
2	BA	History	3	8	23	2
3	BA	History	3	5	20	2
4	BA	None	3	8	20	1
5	BA	History	2	7	20	2
6	Unclassified	None	N/A	5	28	1
7	BA	History	3	N/A	20	2
8	BA	History	3	7	22	2
9	BA	English	2	3	20	1
10	BA	History	3	6	20	1
11	BA	History	3	10	20	2
12	BA	History	3	7	20	1
13	BA	History	3	5	19	2
14	BA	History English	3	6	20	N/A
15	BA	History	3	8	20	2
16	BA	None	4	6	21	1
17	BA	History	3	12	19	2
18	BA	English History	3	9	19	1
19	BA	History	3	12	20	2

Note. Participant data taken from the pre-test survey which asked for demographics. For gender, 1 donates male and 2 donates female.

Comparison of Augmented Reality Applications

Several AR applications were compared based on their viability to the experiment (see Table 3). The comparison variables were based upon the direct needs of the experiment and the researcher. The following criteria were required from the application: free to download from Google Play, relatable to education, user friendly with an interface that is easy to understand; compatible with popular devices such as iPhone7, Samsung, and Motorola; able to create immersive environments (i.e., using a smart phones camera

to overlay information rather than looking at a map interface), and able to create customized content specific to the needs of the chosen topic. All applications were tested on a Moto X Play 2015 with Android 6.0.1. Out of the top 20 applications for AR (Corpuz, 2016) five were chosen based on additional selection criteria. The following applications were disqualified: games such as Pokémon GO, Ingress, Mybrana, or AR Invaders; brand promotion applications such as Hyundai Virtual Guide; apps unrelated to education such as Star Walk, Theodolite, Sunwalk, Inkhunter, Google Translate, Anatomy 4D, Snapshop, and Virtualtee; and applications intended for the use children such as Quiver and Crayola Live Color. Due to budgetary restriction, apps with a download fee were also prohibited. The five apps chosen for comparison from these criteria were: Aurasma, Wikitude, Field Trip, Blippar, and Layar. Following the selection stage, the five passing applications were compared on the primary variables.

Wikitude, from the developer Wikitude GmbH (2017), is an application available from the Google and Apple Stores (Wikitude GmbH, 2017). This application was advertised as augmenting the local area around the user based on entered search terms. The application was free, and it allowed the creation of immersive content. However, custom content was not allowed. The application linked with Wikipedia and was education-based with a user-friendly interface and was compatible with major devices (Wikitude GmbH, 2017). However, based upon the application's limited search terms and the inability to create custom content, this application was disqualified.

Field Trip from Niantic, Inc. (2017) is an educational application available from the Google and Apple Stores (Niantic, Inc., 2017). It was advertised as allowing students and interested users the ability to learn about global content without traveling to the area. The interface was based on Google Maps and the search terms linked with Wikipedia, online reviews, and photos (Niantic Inc., 2017). Unfortunately, the user interface was cluttered and was frequently non-responsive to input. Furthermore, custom content was not available and local content was frequently incorrect; therefore, this app was disqualified.

Blippar from Blippar Entertainment (2017) is a live camera overlay application available from Google Play and Apple Stores (Blippar Entertainment, 2017). The

application included a short tutorial. The app integrated with the test phone's camera function by creating an overlay of search terms and definitions, with links to further information, when the camera is directed at objects, pictures, or faces. However, creating custom content was not supported, and the researcher had trouble getting the application to recognize simple geometric shapes or easily identifiable objects and brands such as an HP laptop or a Sony PlayStation controller. The device created an immersive environment using its overlay technology integrated with the smart phone camera and could potentially be related to education depending on the user's interests (Blippar Entertainment, 2017). However, based upon the inability to create custom content and recognize simple pictures, the application was disqualified.

Layar from Layar B.V. (2017) is a reality-augmenting application available from the Google and Apple stores (Layar B.V., 2017). This application was advertised as being able to supply information on everyday objects with a simple one-tap user interface (Layar B.V., 2017). This supported its user friendliness in addition to its compatibility with major devices and its ability to create an immersive environment. However, custom content creation is not allowed. In addition, the only reality augmentation the application allows is on objects with Layar's branding or a QR code, thereby severely limiting its versatility. Based upon these variables, the application was disqualified.

Aurasma, from the developer Aurasma Entertainment (2017), is a free application downloadable from Google Play and Apple stores (Aurasma Entertainment, 2017). It is advertised as a reality-augmenting application with an educational focus that is specifically for teachers, including the allowance of custom content creation via Aurasma Studios, a secondary app (Aurasma Entertainment, 2017). Furthermore, the application can be locked by the user, limiting it to use with a single group of AR photo triggers. This feature was deemed useful for a teacher. Furthermore, the application allows for the creation of immersive environments using the phone's camera with triggers, videos, text, and music, and is compatible with major devices (Aurasma Entertainment, 2017). Aurasma also uses a very user-friendly interface. Based upon the variables and the allowance of custom content, Aurasma was chosen as the application for the study.

Table 3.

Comparison of Augmented Reality Applications

Application	Aurasma	Wikitude	Field Trip	Blippar	Layar
Free	Yes	Yes	Yes	Yes	Yes
Create custom content	Yes	No	No	No	No
App Related to Education	Yes	Yes	Yes	No	No
User-friendly	Yes	Yes	No	Yes	Yes
Immersive Environment	Yes	Yes	No	Yes	Yes
Compatibility with popular devices	Yes	Yes	Yes	Yes	Yes
Operating System required	Android 4.0 + iOS 8 +	Android 4.1 + iOS 8 +	Android 2.3 + iOS 8 +	Android 4.3 + iOS 9+	Android 4.3 + iOS 8+
Restrictions to Screen size or orientation	None	None	None	None	None

Note. All system information gathered from Google Play (2017), Corpuz (2016) and the iTunes App Store (2017)

Description of Technology Used

The technology used was AR, which has been previously described. The application used for the AR phase is described in further detail below. The application was picked based on the learning goals of increased interaction and engagement.

Aurasma was an AR application that was free to download from Google Play and the App Store (Aurasma Entertainment (2017). The app used photo triggers: specific images that triggered the app to create 3D images. The app could have also used Global Positioning System (GPS) co-ordinates to make an AR image in a certain location without a photo trigger. The student or participant had to install the app on their phones, search for the account they wanted to follow as this account had the images that the

student would later see, and then the app worked immediately. To use the application, the student held up the phone to an area previously marked with an identifying characteristic that was told to them beforehand, and the application handled the rest. Wi-Fi or data was required, but the usage was quite small, on the order of a dozen megabytes per session. Furthermore, battery life for the phone was only marginally less than standard usage.

The app incorporated still images, 3D images, text, video, and audio, thus making it a fully immersive multimedia app; the only caveat being the work required to set up the photo triggers both physically and in the app. In this experiment, the researcher had spent five days researching and gathering the images, evidence, and text, two full days creating the images and text in Aurasma studio, and two days placing them around the campus. Another day was used to test each photo trigger. The photo triggers were subsequently tested on each day leading up to the study in order to potentially replace, fix, or bug test the paths the participants were to take.

The images used were taken directly from poster boards around campus to be used as photo triggers. They were augmented with colored strips of paper delineating groups one to five. The texts were image screenshots from historical documents and contemporary journal articles, and the images used for the characters were Creative Commons licenced. The character text was created solely by the researcher and tailored to reflect speech patterns of the selected era. The characters would reveal certain information that the historical and conventional texts would not, thus providing a reason for the participants to interact with them (see Appendix G for character description). Furthermore, to add to the difficulty, the characters had a fifty-fifty chance to reveal the information. Unfortunately, the participant could simply repeat the conversation to get the desired answer, but subsequent inquiry determined that this did not occur.

Method

Here is where you should describe the kind of research you have done. This is important so that the readers can clearly understand the kind of contributions to knowledge that it is possible for your research to make. It does not appear to be an experiment, but more of a design trial.

The research proceeded in two phases. The preparation before the first phase consisted of meeting with the instructor to determine the topic and focus of the curriculum. After these had been determined, the researcher created the AR curriculum. The first phase was then implemented. Phase one consisted of the instructor teaching while the researcher acted as a passive observer and teaching assistant if needed, and taking field notes (Burgess, 1991; Creswell, 1998, 2008; Sanjek, 1990; Webb, 1991). One survey was given during this phase (see Appendix A for Survey Questions). These questions were adapted from Walton, Hamilton, Johnson, and Arnouse (2010) which focused on demographics, technology acumen and questions on engagement.

The second phase consisted of the AR curriculum and involved the researcher giving instructions, observing the students outside, and taking field notes. The investigator posed a focus question to the students before they left the classroom, on which they collected data and attempted to find an answer. The focus question was "Who killed Richard III's nephews?" It was chosen in order to provide the students with a topic that has proven controversial in history (Pollard, 1991). To control for potential coercion, which could influence the research, no marks were given, and the curriculum was not treated as course work. This phase consisted of Aurasma photo triggers, photographic markers that trigger the application to function, (see Figure 8), placed throughout the university for the participants to search out and take notes on. This mystery hunt occurred with prearranged maps that were created by the researcher for each of the groups in the style of a treasure hunt. The participants were randomly assigned to groups of no more than five students each. The participants collaborated between themselves and other teams, obtaining a fuller picture of the historical topic (see Appendix H for description of historical topic). This session lasted for approximately one hour. A second survey was given during this phase when the participants returned to the classroom (see Appendix B for survey questions). These questions were chosen based upon a focus on AR and its potential effects on student engagement with questions adapted from Walton, Hamilton, Johnson, and Arnouse (2010). The total time allotted for the second phase was one hour and 45 minutes. After the information had been obtained, the participants had 45 minutes to collaborate in their groups to answer the researcher's question to the best of their ability, using the evidence provided.

Figure 8. This photo was used for the experiment as a photo trigger (Abellan, 2016).

Procedure

The study period occurred over two consecutive days for a total class time of approximately two hours and 30 minutes. The professor arrived, and the study began. The professor is a very strong educator and his classes are very popular; reviews posted on RateMyProfessor (2017) use terms such as nice, helpful, and caring in relation to his educational ability. He greeted the students and the researcher, and stated that the researcher would be doing a study and that the normal class had been moved to another day. The professor invited the researcher to introduce themselves and the researcher explained the type of research that they were doing. They explained that they were trying to make history an interesting subject again and that they would be using experimental technology coupled with a historical topic to do so. The researcher asked if the students were familiar with Pokémon GO! Several of them were, and the researcher explained they would be using similar style of technology to present information in a new way.

Upon hearing this, the students seemed interested. The researcher then provided consent forms, which the entire class voluntarily signed.

Phase one: the professor's class. November 7, 2016. The classroom was arranged in a series of long tables with four students per table; there were 19 students in the room, including one who arrived at the end of the class.

The professor asked if the students had done the required reading of a chapter in their text book. The chapter was entitled "Historians in the Digital Age." He asked the students what evidence there was to support the evolution of historians in the digital age and tasked them with discussing the question in groups for about five minutes to generate answers. It appeared that many of the students had not read the chapter, and the beginning of the discussion was rather quiet. After a few moments, the conversation picked up and they started to focus on the task at hand with apparent enthusiasm.

The professor sat at the centre table and proceeded to ask questions concerning the chapter. He switched to a personal story for a few moments and it appeared to keep the students' interest. He asked for examples of historians' craft in the digital age and one student responded that "historical information may not be believable" and that "the 10th century had different approaches to history." The students discussed among themselves again and the conversation appeared to die for a minute until the professor spoke up with another story to pique interest in the topic. Here the researcher made a note describing the possible relation of personal, allegorical, and relational stories which were slightly off the topic to keep student interest. During this time, the researcher also made observations on the student's engagement with the professor and with each other. The subject of student/student engagement is expanded upon in the individual interviews in which students mentioned that the study afforded more time with students with whom they had little interaction.

The discussion lasted for 45 minutes, after which the researcher was invited to set up the AR phase for the next class. The researcher presented a short PowerPoint, and distributed a handout explaining how the activity would happen, and how to use the Aurasma application. Many students set up the app without issue, although the researcher has noted areas where instructions could be streamlined or expanded upon in potential future iterations. Several students had issues with the setup of the app;

however, these issues were minor and quickly solved. The test Aura, which was the application's name for an AR trigger, was placed up on the screen and immediately students crowded around to test the application's functionality. The researcher observed that they appeared interested in the Aura, as the volume of the crowd increased, and laugher was heard as well. The class ended a few minutes later. The researcher noted that the students seemed engaged and enthusiastic about the next class.

Phase two: Researchers' observations. November 14, 2016. The next class was scheduled for November 8th, however, due to the US federal election and the lack of participants on the selected day, the study was rescheduled. The following Monday, November 14th, the number of participants had dropped from 19 to 15 students. Prior to the class where the experiment was conducted, the researcher went through the activity with a small test group that was unrelated to the study.

The test students had been assigned to five groups consisting of three students each. Each test group was assigned a starting point and a set of photo triggers. The groups were asked the focus question "Who killed the Princes in the Tower?" The students were then placed into groups and immediately sent out. The professor did not participate in phase two as the researcher desired that the AR component be separate from the initial examination. This would remove the effect of an extremely strong and competent educator, allowing for AR's effects to be studied alone.

Group 1. Group 1 consisted of three students. They started on the first floor in a different building from the one their class usually met in. The researcher followed them, but did not talk, letting the students talk amongst themselves. Upon reaching the first photo trigger and starting the app, the researcher noted that two of the students seemed impressed, remarking "Whoa." They played with it for a few moments, tapping the screen in various places. It was obvious that they were having difficulty interacting with the program. They turned to the researcher who told them that they had to ask the question by tapping the questions displayed on the screen. The next photo trigger was a simple poster with the group's number underneath. The students quietly talked amongst themselves on how to take notes, settling on a screenshot. Having taken note of this, the researcher left the building to observe another group.

Group 2. The group consisted of three students. They had started in a different building from the one their class usually met in, and different from building the first group used. They immediately approached the researcher, and remarked that they had similar difficulties with character interaction. Upon further questioning, they were the same difficulties. When asked how the study had proceeded thus far, one group member remarked that "It's fun" and a second group member said, "The App is junk." The researcher noted that the second group member was using Facebook on their phone and not participating in the activity, except to follow the others around. This behaviour could have been the result of the application difficulties. The other two group members took photographs of the evidence individually and when they interacted with each other, their conversation was on personal, social topics, and not the class or experiment**.**

Group 3. This group was not observed during the experiment.

Group 4. The fourth group experienced difficulties with the character interaction. They did not know how to ask the character questions. Furthermore, they also showed minimal individual interaction. They each took pictures separately. They remarked that "This is really interesting" and that "This is better than class". The two previous groups also appeared happy to escape the classroom and when queried on this they, replied with similar responses. The group returned to the class, and two of the three participants joined, discussed, and wrote down the evidence. However, when asked, they stated that they would have liked more time to examine the evidence required rather than the few minutes they had, saying that it "Took longer than I thought".

Group 5. Group five was observed when the researcher returned to class. They had completed the study quickly and when asked if they had managed to talk with the characters, they remarked that they had no idea they could interact with them. However, they scanned the evidence they collected and arrived at the same answer as group four, and noted that more time would have been useful. The researcher noted that given the overall difficulty experienced in interacting with the characters, a more thorough tutorial on character interaction would potentially be useful in future tests.

Methods and Data Collection

Surveys. The surveys were conducted in a pre-test, post-test methodology with 19 students having participated in the pre-test and 15 having participated in the post-test. (see Table 2 for participant data and see Appendix A and B for pre-test and post-test surveys). The surveys directly examined the six research questions, although the pre-test collected demographic data and historical content, while the post-test focused on AR. The first survey was conducted after Phase One implementation and the second survey was conducted during Phase Two, after the students returned from the mystery hunt. This survey was provided to each student in the selected history classroom. The first survey consisted of 66 questions, and the responses were based on a 5-point Likert scale from 1 (Strongly Disagree) to 5 (Strongly Agree). The second survey consisted of 47 questions on the same 5-point scale. The survey questions were generated from the research questions and literature review. The surveys were coded and divided into their pre-test, post-test categories and the data transcribed into an Excel spreadsheet program. After verification that the data was accurate, the data was loaded into SPSS (Version 23). Each survey was separated into its own case, similar questions were linked together, and an analysis was performed using SPSS.

Several demographic factors were examined, including gender, age, and ethnicity. There were several questions pertaining to student-to-student and student-to-teacher engagement. The strengths of a survey using a 5-point Likert scale were that it allowed for an examination of multiple teaching methods for AR and it determined the learning preferences of students. Furthermore, the technology's prevalence of use, the educator's and students' experience with the technology, the technology's effectiveness, and general engagement of the students were examined with open-ended questions.

An independent *t*-test compares the means of two independent groups in order to determine if there is statistical evidence that the associated populations were significantly different. The *t*-test is a parametric test. Mann-Whitney U test is the non-parametric statistical test equivalent to the independent t-test.

When comparing two groups of five-point Likert data, the results are generally the same when using a parametric statistic (i.e., t-test) or a non-parametric statistic (Mann-Whitney-Wilcoxon). These patterns hold true for sample sizes of 10, 30, and 200 per group. The *t*-test is typically used because it has more statistical power (the ability of a statistical test to detect a significant difference when there actually is one) (de Winter, & Dodou, 2010). An examination of normality (skewness and kurtosis less than 3.00) found that only three survey items were not normally distributed. However, the *t*-test is robust for violations of normality (Joanes & Gill, 1998). Following de Winter and Dodou (2010), the *t*-test was used to examine changes over time.

For completeness, the Mann-Whitney U test was also run to determine if there was a change in the results. These analyses were very similar to the *t*-test results, although there were two items that were found not significant on the Mann-Whitney U but significant on the independent *t*-test.

Interviews. The study used semi-structured, in-depth qualitative interviews (see Appendices C and D for interview questions). The questions were designed to elicit responses from the participants on the six themes: augmented reality and historical content, augmented reality and engagement with students and instructor, augmented reality and knowledge acquisition, barriers to augmented reality, and participant feedback on augmented reality. The researcher interviewed the participants in the weeks following the study. Each interview lasted about 15 to 20 minutes, and the interviews were digitally recorded with the participants' permission, transcribed, and coded by the researcher to discover thematic patterns across the interviews. It is worth noting that the responses provided by the participants were much shorter than anticipated and asking for elaboration did not always generate additional responses. Out of 19 participants who agreed to the study, and the 15 who participated, four students and the instructor agreed to interviews with the researcher. Finally, of the interviewees, two were male and two were female.

The questions asked of the instructor were similar in nature to those asked of the participants, but were tailored towards curriculum, the overall course, history education, and potential suggestions. It is worth noting that the feedback forms were far more

detailed in certain areas than the interviews. The strength of the research methodology was that students and the educator could further expand on the surveys and their experiences, giving voice to the results since the survey only allowed a 5-point Likert scale response. An additional strength was the ability to illuminate areas in need of address in future research.

Field notes. Field notes were taken during the first and second phases of the study to note how the students reacted to instructor-led teaching and the AR curriculum. This consisted of notes taken in the classroom and on the campus. The criteria of focus for the field notes were taken from the research questions and included engagement with students, content, and the instructor. The observations of participant engagement were based on body language and facial expressions, participant engagement with other participants, and difficulties with the topic and the application (for examples of these field notes, refer to Appendix F). The participants were quoted on their views during Phase Two. The field notes were prepared and reordered into the relevant themes. The notes were expanded on while the study was ongoing in order to provide a detailed and coherent description of the observed events. This revealed emergent themes that meshed well with the chosen themes. Finally, the notes were analyzed along with the interviews and surveys for thematic data in order to provide answers to the research questions. The notes were also studied for participant suggestions, comments, and behaviour regarding the study.

Participant feedback forms. Feedback forms were circulated after the AR phase two was completed (see Appendix E for the feedback form). This feedback form consisted of three questions designed to elicit information on how history education could be improved, how AR curricula could be implemented in the classroom, and suggestions for the study itself. 15 feedback forms were circulated and retrieved. The feedback reported was divided into two broad categories, positive and negative, based on the responses garnered from the feedback forms, and was further sub-divided in those categories into constructive criticism and destructive criticism. There were also neutral comments that were gathered and assessed for thematic data.

Chapter 4

Results

These sections present the themes identified through thematic analysis of the mixed-methods research data. This data includes observations, interviews, and feedback as well as the statistical data collected and analysed through SPSS.

Data Sources

There were three sets of qualitative data sources and one quantitative source: student interviews and feedback forms, the instructor interview response, and the researcher's field notes during phases one and two. Both sets of interviews were a research strength because the students could elaborate on thoughts and feelings from the study: they were able to respond to specific questions regarding the research and create an understanding of areas that were useful to the study. The professor responded to specific questions with his own teaching expertise and offered his thoughts and constructive feedback.

In addition to the interviews, participant feedback on areas of AR barriers allowed for continued elaboration. The participant feedback forms were extremely useful because they allowed the students to describe areas that needed improvement or elimination. Furthermore, they suggested alternatives to specific themes, topics and technologies used and proffered new areas for the researcher to study.

Additionally, written observations during both phases of the study allowed the researcher to examine student reactions to the experiment. The researcher used the field notes to expand upon observed behaviours and noted areas such as collaboration that provided detailed data.

Finally, the surveys incorporated quantitative data for the research study and revealed statistical significance and correlation on the research themes. These sources of data are strong because they were used to determine and triangulate areas that were consistent in responses and those that vary.

Research Themes

This section will present answers to the research questions asked in the study (see the Literature Review for the list of Research Questions). The research questions are organized into common themes that may include more that one research question.

1. Augmented Reality and Historical Content, Research Questions 1-2.
2. Augmented Reality and Engagement with Students and Professor, Research Question 1.
3. Augmented Reality and Knowledge Acquisition, Research Question 3.
4. Barriers to Augmented Reality, Research Question 4.
5. Participant Feedback on Augmented Reality, Research Question 5.

Augmented Reality and Historical Content: Research Questions 1-2

AR and historical content was assessed in the context of an extremely engaging professor (M = 4.26 out of 5.00 on engagement with instructor from student survey). Since the professor's engagement with the students was very high, and the semester was nearly finished, an increase in engagement with content or the teacher was not expected.

Survey results on historical content. There were five survey items (items 16, 25, 26, 27, 28) designed to assess the effect of the AR experience on increasing engagement with the historical content. An independent *t*-test was used to examine any possible changes in engagement from the pre-test to the post-test (see Table 4). A Wilcoxon sign ranked test was also used and produced the same results. All *t*-test analyses found that there were no statistically significant changes in engagement with content from the pre-test to the post-test.

Table 4.

Survey Results on Augmented Reality and Engagement with Content

Item #	**Pre-Test M (SD)**	**Post-Test *M (SD)***	***t***	***p***	$\dot{\eta}$
The historical content was engaging (16)	3.95 (0.52)	3.57 (0.85)	1.46	0.160	0.071
History teaching methods are relevant (25)	3.89 (0.73)	3.73 (1.03)	0.53	0.600	0.003
The history topic was appropriate (26)	4.53 (0.51)	4.20 (0.77)	1.48	0.250	0.048
The history topic was challenging (27)	3.84 (0.77)	3.47 (0.99)	1.29	0.221	0.051
The history topic was biased (28)	2.37 (0.60)	2.60 (0.99)	-0.85	0.403	0.025

Note. Scores ranged from 1 (Strongly Disagree) to 5 (Strongly agree).

Survey results on teaching methods. There were five survey items (items 19, 20, 21, 22, 23, 24) designed to assess the effect of the AR experience on teaching methods. An independent *t*-test was used to examine any possible changes in engagement from the pre-test to the post-test. All *t*-test analyses, except for items 20 and 22, (see Table 5) found that there were no statistically significant changes in engagement with content from the pre-test to the post-test. Items 20 and 22 decreased at the post-test.

Table 5.

Augmented Reality and Methods

Factor (Item #)	**Pre-Test** ***M (SD)***	**Post-Test** ***M (SD)***	***t***	***p***	$\dot{\eta}$
The teacher used critical inquiry to teach history (19)	4.00 (0.82)	3.33 (1.40)	1.64	0.120	0.064
A textbook was the primary source (20)	2.50 0(.86)	1.67 (0.72)	3.00	0.006	0.227
PowerPoint was the primary source (21)	2.21 (1.13)	1.93 (1.22)	0.68	0.500	0.022
Critical inquiry was useful (22)	3.84 0(.90)	3.00 (1.00)	2.58	0.015	0.161
Primary sources were presented through text or pictures (23)	4.00 (0.94)	4.13 (0.74)	-.46	0.660	0.003
Secondary sources were presented through text or pictures (24)	4.34 (0.82)	4.07 (0.46)	1.12	0.271	0.035

Note. Scores ranged from 1 (Strongly Disagree) to 5 (Strongly agree).

Based on field observations, the participants appeared engaged, but this could have been due to the AR technology or student to student cooperation and social behaviour. Furthermore, based upon the interviews with four participants, there was no increase in engagement with historical content. Unlike the survey results which found no change in engagement with content, there were individual exceptions with the interviewees; (e.g., Participant A stated, “Having to do it again helped me understand and engage more” and Participant B said “No” when asked if AR increased their engagement because of technical issues with the application). Participant D remarked that if there was a more hands-on approach, they would have been more engaged.

The professor indicated that it appeared to be very hard to say if there was an increase in engagement with the historical content. He remarked that “We had already read Tey.” He further stated that “I’m not sure…other than the students having a fun experience…I’m not sure it specifically increased historical engagement.” Thus, perhaps a new topic would have been more suitable with the students than one with which they were already familiar.

Among the students interviewed, a variety of topics were reported as preferential and engaging. This included the World Wars, Canadian history, mystery themes, historical architecture, and historical household tools. Furthermore, a visual mystery was indicated as preferential, if changes were made to include presenting unique mysteries to each group in class. The professor described that many students taking history opted for the more dramatic courses such as the World Wars or the Gulag. He stated that the department offered more seats in those classes, but waitlists were still prevalent. He noted that topics such as sex and gender hold relatively small class sizes in relation. The mystery themed hunt appeared to engage the participants immediately during the setup and implementation. They appeared to enjoy gathering clues toward an eventual understanding and revealing the answer to the mystery. Additionally, during the interviews, the students expressed interest in the provided topic and suggested that the mystery hunt be broken into sequential pieces; a single mystery for each group in the classroom along with a think-pair-share activity afterwards. The class professor suggested that the students were already familiar with the topic and that perhaps a new topic would be more beneficial. Participant C indicated that having multiple concurrent mysteries, unique per group, may have increased engagement. They also suggested using AR as icebreakers.

The study results indicate that the more dramatic historical themes such as the World Wars and those that held an enduring or solvable mystery would be courses that sparked the most interest and have the potential for increased engagement for history courses and for adaptation to use with AR. Thus, a new AR topic may do the same if the class found them entertaining. However, one interviewee reported that historical architecture and tools would be of interest rather than the more dramatic courses. AR already has a venue in highlighting historical buildings, as seen in popular media, and this could be adapted for the classroom or campus (Yuen, Yaoyuneyong & Johnson, 2011). All participants and the instructor expressed interest in seeing the AR study conducted in a high school or elementary setting, suggesting that the novelty and techniques used would promote more student interest. The students and instructor expressed interest in AR and a further interest in related topics, but a preference for mystery and dramatic topics was shown.

Augmented Reality and Engagement with Students and Professor: Research Question 1

AR and engagement with students and instructor was assessed in the context of an tremendously engaging professor (M = 4.26 out of 5.00 on engagement with instructor) and already engaged students (M = 4.37 out of 5.00) who were over three quarters into the semester.

Survey Results on AR engagement with students and professor. There were seven survey items (items 16, 17, 36, 40, 42, 45, 46) designed to examine if the AR experience affected student to student engagement and student to teacher engagement. Independent *t*-test analyses found that five items did not change from the pre-test to the post-test (see Table 6 and Figure 10). Item 18 "I was engaged with my professor" showed a decrease during the post-test, while 17 "I was engaged with fellow students" remained high during both tests. However, the survey item that asked, "I was engaged with my professor during class time" decreased significantly at the post-test. $t(31)= 4.76$, $p<.000$. Additionally, item 40 that asked, "The relationship with my instructor is important" decreased slightly during the post-test. $t(31)$ 2.56, $p<.015$. Demographic questions were assessed for a statistical impact on responses, but no statistically significant results emerged. Scores ranged from 1 (Strongly Disagree) to 5 (Strongly agree).

Table 6.

Student and Teacher Engagement

Factor (Item #)	**Pre-Test** ***M (SD)***	**Post-Test** ***M (SD)***	***t***	***p***	$\dot{\eta}$
I was engaged with fellow students (17)	4.37 (0.50)	4.29 (0.47)	0.48	0.631	0.003
I was engaged with my professor (18)	4.26 (0.56)	2.71(1.27)	4.28	0.001	0.408
Instructor methods made working with fellow students' easier (45)	4.68 (0.58)	4.26 (0.63)	1.54	0.140	0.063
Instructor teaching increased engagement with students (46)	4.37 (0.58)	4.36 (0.63)	1.54	0.140	0.059
A good relationship with my teacher enhanced learning (36)	4.47 (0.69)	3.86 (0.66)	1.09	0.290	0.038
The relationship with the instructor is important (40)	4.42 (0.61)	4.14 (0.77)	2.56	0.015	0.161
The relationship with the instructor is important (42)	4.42 (0.61)	4.14 (0.80)	1.20	0.254	0.048

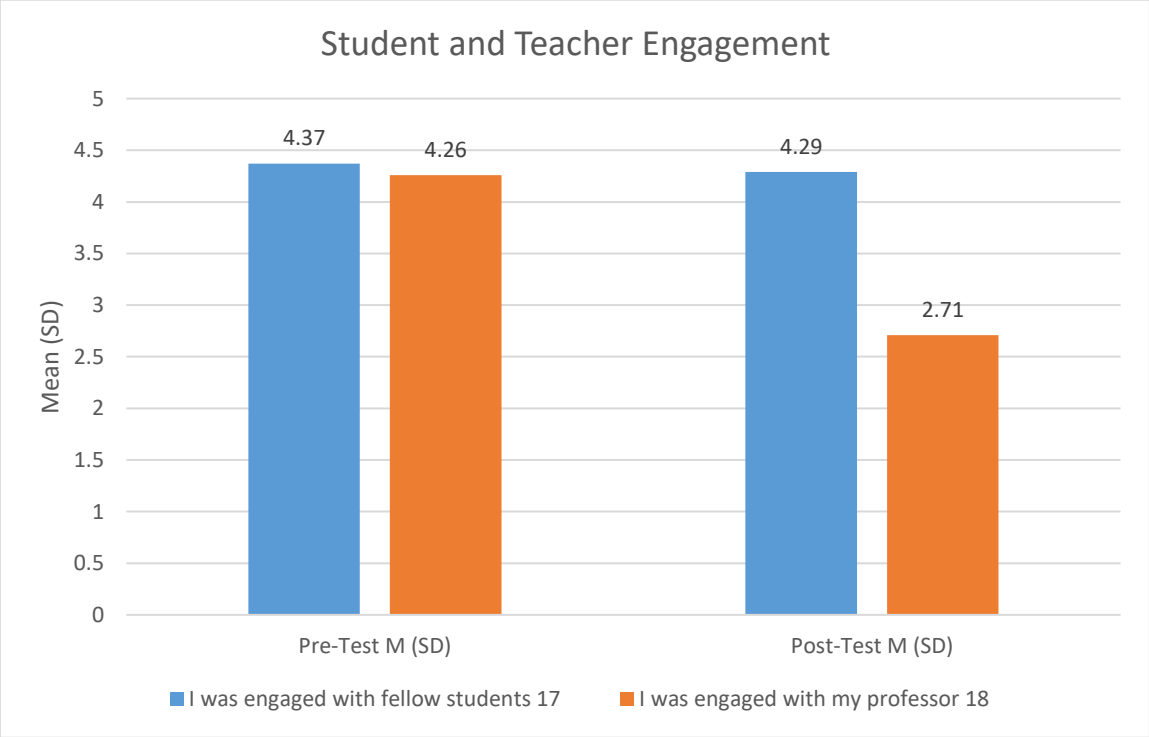

Figure 9. This graph shows the survey items 17, and 18.

The researcher's observations indicated that the students appeared engaged during both study phases. The researcher observed that they were engaged with the class professor and responded to his questions with insight and relevant answers. At the end of phase one when the researcher was setting up the students' applications, they appeared engaged with him. They asked questions and expressed interest in the way the application presented information. During phase two, the students individually collected data from the photo triggers but talked amongst themselves and remained in their selected groups. Additionally, they appeared to have little engagement with the researcher, only asking him questions when the app failed to work properly. Once they returned to the classroom, several groups collaborated within and across groups, studying the evidence provided to ascertain an answer to the key question.

Unlike the findings from the survey results, which found no changes in student to student engagement, some interviewees indicated that they saw the exercise favourably in that it allowed them to engage with their classmates. Participant A stated that "We had to actually kind of talk and figure things out." They also reported that they had to interact with students with whom they would not normally interact with. Participant C spoke well of the student to student collaboration, stating "Yes those are students that I never worked with. They sat on the other side of the long tables. I actually got to talk with them, going around with them, helping them learn the content." It was also noted that the topic was more hands on and interactive than the previous in-class exercises. Participant B stated that the AR phase was "More interactive than a lecture." Participant D noted that AR increased their collaboration with other students, but it was also dependant on the goal that was provided.

The professor agreed that the students worked more with each other and saw AR as a chance to get out of the classroom and work on an activity besides a lecture. He also likened it to having a guest lecturer in that it was a change of routine and a different way to study history: "It was like a bonding experience for the students." This bonding experience during the study was potentially a positive indication of student to student engagement.

The interviewees expressed that they were not engaged with the researcher during the AR phase (phase two). They noted that the researcher was not directly supervising them or interacting with them. The professor said that it likely did not increase his engagement with the students as "It was already a fair way in to the semester." He also stated that it was hard to tell if the AR increased the student engagement with the instructor. The reason behind the lack of professor involvement with phase two was that the researcher wanted to study the effects of AR on engagement with content separately.

The interview results indicate that some students were engaged with their fellow students because of the method used in the mystery hunt. Although they did not always collaboratively work on the topic outside the classroom, they did engage with one another, talking and bonding. Furthermore, in the classroom, they worked together to study the evidence provided and the students all agreed that they had more interaction than from a usual classroom experience. They were also observed looking at the photo triggers collectively in their groups and pointing out "This is really interesting" (Group 4). Furthermore, they indicated that they had to work together to solve the mystery and analyze the data, often helping each other with the historical content and technological problems that arose.

The survey results showed that they were engaged during phase one, but their engagement decreased during the AR curriculum. Students were engaged with the professor during phase one as he was a very strong educator while students were not engaged with him or the researcher during the AR phase of the study; the survey results show a marked decrease in engagement during this time. Participant D offered a potential solution, stating that "It has potential to…If we go back and discuse[ss] [the content] more. If [the researcher] followed them around. [Augmented Reality] could do that if you were our teacher."

Augmented Reality and Knowledge Acquisition: Research Question 3

AR, according to the observations, did not appear to increase the acquisition of knowledge about the topic. However, some participants stated they acquired knowledge based on the evidence provided by the photo triggers. The interviewees indicated that they had no increase in their acquisition of knowledge, although Participant A expressed

satisfaction in going over the content a second time. Participant D expressed frustration, stating "Did I learn it or already know? Potentially a valuable learning tool. Tried again, and it was information that we haven't seen before." No interviewee expressed an increase in knowledge by way of the AR experiment, but they did state that it was a new way of acquiring the same information that they would have gotten from a lecture. Furthermore, the professor stated that it was very hard to tell if the students were using knowledge they had had previously, or additional new information.

Based upon the results, in this single study, AR did not increase the student acquisition of knowledge, but it did reinforce existing information. Potentially using a topic that has not been explored by the students would provide a new answer to the research question along with a larger sample size of participants in a new study.

Barriers to Augmented Reality: Research Question 4

The study revealed several barriers to using AR in a classroom, including time to set up, difficulty of incorporation into the curriculum, difficulty of the topic, methods used in the topic, and the experimental nature of the technology. Another barrier participants indicated was the amount of content and the length of time needed to set up the photo triggers around the campus (Participant A and B). A third barrier to AR was not having an educator to keep the groups on task during the investigation when they were out of the classroom. Participant D thought that it may be difficult for some professors who to prevent students from using their phones in class to adapt to using AR.

Technology experiences related to AR. There were 18 survey items (items 47-64) (see Figure 11) designed to examine the student's experience with common technology including AR and virtual reality. A frequency test determined the percentages of participants that used each corresponding technology. The participant's experiences with technology included texting, Facebook, and Moodle rated highly (> 4) while their experience with AR was low (< 2). Their inexperience with AR could account for the decreased engagement with content in several survey items (see Tables 4, 5, and 6).

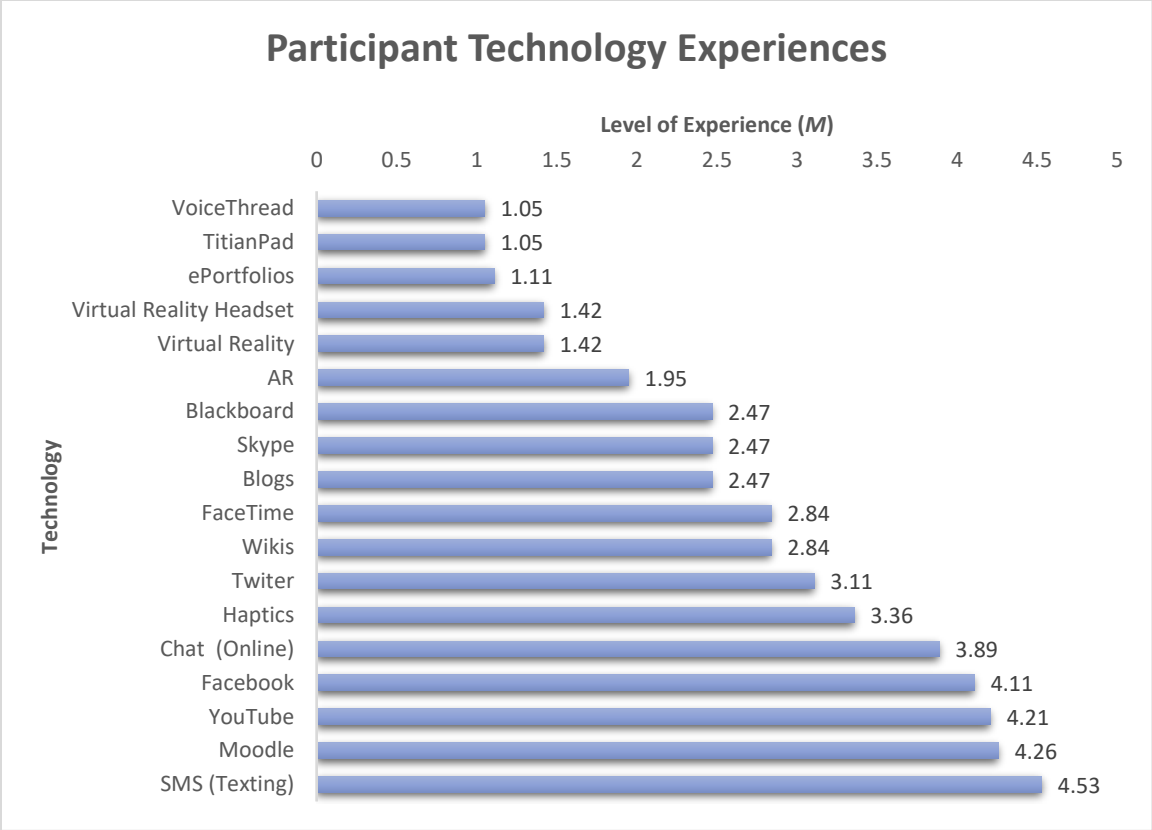

Figure 10. Participant Experience with Technology. The scores ranged from 1 (None) to 5 (Extensive) and are measured in mean.

The professor indicated that the students needed a better understanding of how AR works:

I would recommend having the students do a trial run before doing it. Even set up mini assignment to make things work. It's not the key element, it's more about understanding the complexities of the past and what goes into the past, how you get the [historical] past into the AR game.

This recommendation was in line with the frequency data (see Figure 10) and the interviews with participants. They were familiar with Pokémon GO but few had played before the study and most were not familiar with the technology behind it.

Participant Feedback on Augmented Reality: Research Question 5

Interview feedback. Feedback retrieved from the interviews varied in the scope of their responses. Participant A stated that more explanation of the app and the topic, as well as a specific mention of the characters, and a different method of utilising the photo triggers would have helped increase their engagement. They also stated that "It can't be as interesting as a seminar." Participant B indicated that less technological problems and more varied topics would have increased their engagement and provided "augmented reality more legitimacy". Participant C mentioned that "younger children may benefit from the technology, such as those in high school or university as they are already using technology". Participant D said that icebreakers along with the gradual introduction of content would help reduce confusion. They also said that they were "Used to talking with group members," and having a discussion afterwards might make them share more information.

Class feedback. When provided with feedback forms and when queried on the first question improving history education, the participants suggested more open discussions in addition to hands-on work and excursions. Historical movies and novels, multimedia presentations and Aurasma (the AR app) for younger students, such as kindergarten and high school, were also requested.

The second question asked participants how AR could be used in classrooms: Several responses included helpful suggestions. Suggestions, included that AR should not replace primary teaching, it was difficult and time consuming and, a better application and introductory summary would improve AR usage as a secondary teaching method.

The final question asked participants for suggestions on the study itself. Responses varied but included answers similar to those of the previous question: A better application along with dedicated spaces for photo triggers, better explanation of the task, purpose, and technology. Participants also suggested adding more time for field work and post discussions. The increased timeframe was widely desired and would allow for further discussion. This, along with a more detailed timeframe and set goals, may help students engage with the topic to a greater degree. They also stated that the AR app should be used with a younger audience and geared more towards younger learners with

suitable historical topics. Finally, they said that creating a task-based mystery that has a step-by-step sequence would also be a valuable change.

Summary

This section presents a summary of findings on research questions and data.

Augmented reality and historical content. The post-test survey showed no statistically significant change, although the interviews with the participants indicated an even split between agreements and disagreements when asked whether the AR environment increased their engagement. The interviewees reported that the more dramatic topics such as the World Wars, were topics of greater interest and that topics such as sex and gender were of less interest. The AR curricula that the participants indicated would be engaging were mystery themed, specifically, content that students could work together in a group to solve or arrive at an answer based on the evidence.

Augmented reality and increased engagement with students and professor. The survey results indicated that students did not experience increased co-operative work relationships with each other during either phase, and that the AR study did not increase their engagement and collaboration with their fellow classmates. However, the interview participants indicated that they engaged more with their peers during phase two than they did during phase one. Furthermore, they talked with students that they normally had no interaction with on a regular basis. The students were engaged with the instructor during phase one, but this decreased sharply during phase two. During phase two the participants, according to survey data, indicated that they felt less engaged with the instructor.

Augmented reality and knowledge acquisition. The interviewees and the survey results indicated that there was no increase in the knowledge acquired in history classrooms during the AR phase (phase two). The participants indicated that the historical research methods they learned in class were different than the skills required for the AR phase.

Barriers to augmented reality. The barriers to using AR in the classroom that the interviewees indicated included that the technology was not effective enough given its current development. The primary problems the participants reported were the

application crashing, frozen photo triggers, and confusion over how to interact with the characters. They also reported that the AR could best be implemented at the elementary and high school levels and more time to set up the AR was needed.

Participant feedback on augmented reality. The participants provided detailed feedback on the AR used in the classroom and suggestions on how it could be improved and deployed. They also provided information on how history instruction could be improved and implemented differently in the future. The results from the feedback forms were valuable in charting a path to improve the AR experience.

Chapter 5

Discussion and Conclusions

Augmented Reality and Engagement with Historical Content

The participants, during both phases of the study, appeared engaged with the content as per the interviews and feedback. The engagement in the first phase can be attributed to the strong teaching methods of the class professor, and the number of topics chosen for the course content. Furthermore, he employed anecdotal stories and face-to-face seating methods along with discussion and inquiry to maintain engagement with the content.

During the second phase (AR), the students' engagement with content did not change and was not statistically significant as seen in the surveys. However, according to the interviews and feedback, several participants expressed engagement with the AR topic. The topic, while already familiar to the students, was presented in a different way than the historical teaching methods the students were used to receiving. The first display of the AR technology resulted in the students crowding around the researcher attempting to use the application.

Several students expressed uncertainty on the AR experience as it was an unfamiliar topic to them. During the interviews, historical content and several historical topics were identified that could, if adapted for AR, be used in an AR curriculum. These topics are more dramatic and include World Wars 1 and 2. However, these topics may lack Canadian history, which the interviewees reported as less dramatic. Canadian history does have an exceptional opportunity for use in AR, and this could increase the student interest in the topic. The use of AR emerges as an important area in the study of Canadian history.

Survey items. The survey items found no significant differences from the post-test to the pre-test surveys. A potential explanation for the lack of significant engagement with the content could be student familiarity with the content chosen for the study and the exemplary teaching methods of the professor. Participant C was the only interviewee who expressed a desire to learn more about the topic. The other participants expressed interest in the topic but no desire to learn more. Thus, a new topic with historical content identified from the interviews could potentially show different results on engagement.

Additional participant experience with AR technology may have resulted in an increase in engagement. The professor's suggestion of a slower introduction, or tutorial could prove useful in building interest and engagement in the future.

Augmented Reality and Engagement with Students and Professor

Survey results on student to student engagement showed that there was no statistical change on engagement. This was interesting because it showed that the students were already engaged with each other during class time and this did not change during the AR phase. However, student to student engagement increased according to the interviews and feedback, and the participants expressed that they had interacted with unfamiliar classmates in a way that was not demonstrated during a seminar interaction.

Survey results on student to teacher engagement showed that students average ratings on two items (17 and18) decreased during phase two (AR). The professor was not participating in the second phase of the study because the researcher wished to test AR`s effects on student engagement with content and student to student engagement on their own without the effects on an exceptional teacher. Item 18 showed a decrease during the post-test. This was interesting because it showed the effect of a strong educator and the effect of a student to teacher relationship on engagement. Student-to-teacher engagement could have increased with strong teacher direction during the second phase, a tutorial and increased time to analyse the historical data. Student to teacher engagement was strong during the first phase due to the professor's teaching ability. However, it decreased during the post-test phase (AR). This could have been because the study took place well into the semester and the students were very used to the professor's teaching style and the topics. The new presentation of a familiar topic with a guest lecturer could have been a cause of the decrease in student to teacher engagement. There is potential for a longer duration test to see if, over several days, student to student engagement increases further with continued use of AR technology. There is also a potential for an increase in engagement if an educator maintains an active role during the mystery hunt, guiding students and answering questions, and solidifying their goals with a designated time limit.

Augmented Reality and Knowledge Acquisition

Data to answer this topic was collected by interviewing four students. The four students interviewed, reported that they did not gain appreciable historical content

knowledge from the AR experience. Because they were already familiar with the topic they reported that the historical content information was not new.

Barriers to Augmented Reality

Data to answer this question included surveys on technology experience and interviews. One of the barriers that the participants noted during their interviews was that the AR technology was not effective because of the application crashing, freezing and not recognizing photo triggers. AR technology is still in its infancy with regards to mobile phones. Over time, the processing power and abilities of mobile phones will improve. However, testing multiple applications to determine the best one would be worthwhile. Furthermore, the technological problems reported during phase two can be fixed in two ways: First with improvements to the application and a wider range of test phones, and secondly with improvements to the technology itself over time. Now that AR has been introduced to the mainstream by Pokémon GO, improvements to the technology could potentially be much quicker and the AR application more robust. Additionally, the characters the students had difficulty interacting with could be voiced or animated, and the curriculum could include a short tutorial on how to interact, since the researcher noted that all participants had issues with interaction.

Technology experience related to AR. The students' rated their experience with AR as low in the survey ($M = 1.95$) which represents 'Very Little'. The student's limited experience with AR technology could have been a barrier during the second phase of the study. This might have been resolved with explicit, step-by-step instructions on how to use the application. The difficulties stemming from this, including program crashes, and freezing, could have acted as another barrier during the experiment. Furthermore, the students were only experienced with social media technology and one interviewee had little experience with smartphone technology and found working with it difficult. The professor's suggestion of starting small and introducing students to AR via short tutorials would be useful in increasing their familiarity with application and fixing errors:

I would recommend having the students do a trial run before doing it. Even set up mini assignment to make things work. Its not the key element, its more about

understanding the complexities of the past and what goes into the past, how you get the [historical] past into the AR game.

AR can be used at lower levels of education such as elementary school which was supported by the participant interviews and feedback. Furthermore, a lower level educational level with a more relevant topic could potentially increase the student's engagement with the topic, among students, and the instructor. The participants expressed that the long time needed to set up the technology was also an impediment: a streamlined setup process could reduce this time. Additionally, the multiple and varied smart devices used by the participants in the study may have had an impact on their experience and contributed to a technological barrier. The participant's smart devices, while meeting the technical requirements of the application (see Table 3), may not have worked correctly, causing the instances of freezing or crashing that were reported. It was observed that many participants had different types of devices and the requirements of the AR application were vague (Aurasma Entertainment, 2017). As has been noted, the application crashes or freezes and created technical issues and the participant became disengaged with the historical content. Therefore, a potential solution for this is to deploy a single type of smart device that would be confirmed to work flawlessly via testing, with Aurasma or another AR application.

Participant Feedback on Augmented Reality

Subsequent analysis of the observation notes revealed several areas where the application and implementation of both the study and AR could be improved. Positive remarks and indications of success also arose from the observations. These will aid future research in terms of revising the program, as well as in designing AR curricula. The researcher's observations and interviews indicated that participants in the AR phase appeared to collaborate with each other to a greater degree than they would have in a normal classroom lecture. Furthermore, despite the technological malfunctions, the participants who continued to work with the application provided useful feedback on the photo triggers, characters, and locations where they were used.

The researcher noted that there were several immediate problems in implementing the AR phase of the study. The students were unfamiliar with the researcher and only

approached them when the application presented problems. Instances occurred during setup where some of the participants were unable to sign up for the Aurasma app and had to be aided by the researcher, taking time away from other tasks. Additionally, it was noted that the participants had trouble understanding the goals and requirements of the study and that they seemed already familiar with the historical content.

The most critical barriers included: (a) a lack of time for the participants to discuss the evidence, with some groups returning far too late to do so; (b) difficulties with the photo triggers, and finally (c) lack of interaction with the researcher-created historical characters. Many of the participants did not respond to calls for interviews and were absent for class in phase two. Many of these problems can be addressed by implementing changes such as increased experience, tutorials from an educator, and advances in AR technology. Despite the barriers, the findings in this study could still be instrumental in creating an improved version of the AR that caters to the needs of both the educator and students.

Discussion

All four groups that were observed appeared to have a generally favourable opinion of the experiment, remarking that it was "better than class" (Group 4 Participant) and "more interesting than a PowerPoint" (Group 4 Participant). Furthermore, based on the observations, the students seemed happy to interact with their peers while walking and reviewing evidence, and to explore individually when collecting evidence. The observations revealed several interesting areas that the participants noted as either engaging or needing improvement. Participants noted that the AR application itself was interesting, chiefly in its use of teaching history. They further indicated that the researcher-created characters had depth, and the information they relayed was relevant to the topic. The participants also suggested recommendations for the AR study.

Recommendations

The participants suggested that AR be used with an elementary school classroom. This would allow for the assessment of potential increases in collaborative engagement factors and could increase the acquisition of knowledge when teaching relevant history

methodology as shown by the effectiveness of previous research (da Rocha Seixas, Gomes, & de Melo, 2016; Schrier, 2005; Squire & Jan, 2007).

Additionally, the researcher recommends implementing the improvements suggested by the observations, participant feedback, and the interview participants. These include, but are not limited to: better application functionality, improved photo trigger placement and sizing, detailed instructions on the application and topic, hands-on tutorials, and simpler characters with voices for increased interactivity. Also suggested are increased and better-defined time limits, multiple topics, the educator being present with the students during the AR phase, and a younger audience, made up of elementary school students with an unfamiliar topic. Also implemented could be: an in-game achievement system, software-based achievement badges, and a way for students to assess themselves based on other students, as these tools have been shown to increase engagement (Sailer, Hense, Mayr, & Mandl, 2017) and are based upon the four engagement concepts described by Stott and Neustaedter (2013). Finally, the creation of recall questions for the students at the end of the traditional and AR phases to assess the potential increase in knowledge and whether AR has a positive or negative effect could prove beneficial.

The researcher recommends that a new mobile application be specifically developed for the classroom and tailored to the needs of students and the professor, including ease of use, reliability, and modularity. As expressed by the participants and the class professor, AR has potential to be useful in education if used in the proper circumstances with an engaging topic.

Finally, the study repeats the calls made by Egan (1979), Egan and Judson (2009), Dewy (1879), Seixas (1999), and Freire (1970/2005) to modernize the curriculum based upon the student needs and society of the modern era. Doing so has the potential to open a new era of education that will meet and exceed the needs of students for years to come.

Implications

The practical implications of this AR study shows what to do, what not to do, and what practitioners could do to use and enhance AR.

AR could be used in a context where students are not familiar with the topic and the AR content should be a digital overlay enhancing the users experience rather than

supplanting it with non-related images. Furthermore, the application should be bug tested to stand up to the rigors of multiple users. This implies that the student will have a tutorial or a method of learning the application, and clear goals beforehand. Finally, the application content should be made to be intuitive and as uncluttered as possible to allow for easy of use.

The implications for practitioners are several. AR can be used in education to teach in a different way that students may not be used to in the classroom. AR may impart more pressure, time, and difficulty on the teacher when they are presented with a new way of creating a curriculum which could influence them to return to their tried and true methods. AR might not provide an increased engagement factor. Finally, AR can be unfamiliar to the students and the teacher and may not present any new gains for teaching when the current methods are already displaying positive results. AR can only provide another method of education that some students may respond favourably to in certain circumstances as shown by this study.

Conclusions

Student engagement with content did not increase during either phase of the study. However, historical topics were identified that could potentially be more engaging and preferential for students. These topics included more dramatic areas of study such as the World Wars and the Cold War. Topics seen as less dramatic were deemphasized due to student disinterest, although they should have a place in an AR curriculum. Canadian history does have exceptional opportunities for use in AR, and these opportunities could increase student interest in the topic.

According to the survey results, overall student to student engagement did not increase during the AR phase of the study. However, during the interviews, feedback and observations, the participants expressed that their collaboration did increase outside of the classroom during the AR phase. This increase in collaboration could be related to the gamified aspect of the AR experience (da Rocha Seixas, Gomes, & de Melo, 2016). The findings from the data, subsequent theming, and analysis, showed there was a potential to incorporate AR into the education system. This AR experience could be explored for the benefit of modern students.

Limitations

The limitations of the research included a small sample size which totalled only 19 participants. There were technical issues related to the AR application which may have affected the results. Only four participants responded to calls for interviews as the study took place near the end of the semester when students are most busy. Furthermore, it must be considered that this was a study with a small sample and so the findings should only be generalized to similar circumstances. This study had mixed technological success because the AR was not used to the best potential as the participants were already working with familiar content.

Furthermore, the study provided an index into unrelated digital materials used as photo-triggers and did not immerse the students with a digital annotated overlay. This limitation could be addressed in future research with real world annotation and immersion implementations of augmented reality.

Future research

Future research can potentially create an improved AR curriculum using the findings from this study, which included, recommendations from the participants. Also, the best practices from current research on AR could be incorporated along with this research to further enhance student learning. Adding AR tutorials to preface the AR content, involving the professor directly, and new topics for the students could improve the student AR educational experience.

This new AR curriculum could be developed and deployed in a university history classroom, or elementary general classroom for short periods of time. Less than three hours in individual lessons to examine effects on learner interest and engagement along with the continued feasibility of using AR in education. Furthermore, outdoor AR activities could also continue to be studied, such as those based at heritage sites, museums, or location-based games on campus.

The areas that participants noted as needing improvement were: Instructions for participants, character interaction, participant collaboration, photo triggers/GPS, theme/topic and content, and the AR application. Based on the observations, the researcher concluded that several immediate and simple improvements could be

implemented. First, the character interaction could either be demonstrated visually with a demonstration character or explained via PowerPoint. Moreover, the characters could be voiced to raise student interest and engagement.

Additionally, the photo triggers could be elaborated upon, and a new method of taking notes could be used in lieu of screenshots (see Figure 8). A medium and area can be chosen where the photo-triggers will not be removed by persons not participating in the class or study. The evidence text could be made larger to facilitate ease of reading. The time students are given to complete the experiment, generate a solution, and find an answer could be extended.

On the technological side, the AR application could be improved by further development or superseded by a different AR application that included enhanced functionality. In case that the AR application could not be used across various devices, the participant groups could decide among themselves how best to take notes. For example, participants could pick one student whose phone or device was working and rely on them to use the photo-triggers while the others take notes.

The surveys could be revised based on the results of the current study. Additions to the survey could also ask for student experience with video games and the social media applications Instagram and Snapchat. Further survey questions could include:

(1) Does augmented reality increase your motivation with historical content?

(2) What achievements in history classes do you see determine as preferential and engaging?

(3) Will augmented reality enhance your engagement?

(4) What learning outcomes have the most effect on your participation and engagement when using AR?

A revised survey with the addition of these items would be extremely useful for other researchers in AR.

Gaps in the literature include: modern technological curriculum and methods that are related to the way students learn in a digital world. Furthermore, increasing student to

teacher reliance and interface with technology for successful education and studying the student shift towards increasing connectivity and demand for instant information. Additionally, the impact of Generation Z or Cybrids, on the above areas and effective teaching methods tailored to their learning preferences (Orange, 2016).

Finally, there is potential for a larger study with an increased sample size, multiple topics, applications, and smart devices to study results regarding the use of AR using the AR design methodology as shown by the AR framework created by Santos et al. (2014).

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Appendix A: Pre-test survey

Phase Survey 1 for Participants

Research Project

File Number: 101322

Approval Date: October 25, 2016

Expiry Date: October 24, 2017

Evolve your History: Learner Engagement in the History Classroom through Augmented Reality

Principal Investigator: Lachlan Gonzales

Graduate Student

Faculty of Education and Social Work

Thompson Rivers University, Kamloops, BC V2C 0C8

Phone 250-814-3885 Email: Lachlan.Gonzales@Gmail.com

The researcher is looking to use an advanced technology in classrooms called augmented reality, a computer overlay of information on the real world, to study the engagement of history students on historical content and other areas and see if augmented reality increases said engagement. I am pleased that you have consented to be interviewed. Your feedback is important to help me understand how augmented reality effects your engagement with history content and the education of history at TRU. This will be used to potentially create an augmented reality curriculum to increase student engagement. This survey is designed to elicit information about: engagement with historical content, student-student relationships, and student-teacher relationships.

Your responses will be kept strictly confidential, no information collected can be used to identify you and you may opt out at any time without any consequences. The survey should take about fifteen (15) minutes. If the survey has been completed it will be

assumed consent has been given. If you have any questions or concerns, you may contact me at the above number or email.

Thank you for participating.

==========

Demographic Information

1. What program are you enrolled in? _____
2. What year of your program are you in? _____
3. How many history courses have you taken? ____
4. Does your teacher use educational technology (e.g., Power Point or Moodle) _____
5. What is your major? _____ B) I have none _____
6. Age: ____
7. Do you identify as: First Nations__ Metis__ Inuit__ Non-Indigenous__
8. Gender: Male __ Female __ Other ___
9. Where have you lived most of your life? Rural community__ Urban community__ Both about equally__
10. Can you speak a second language? No__ A bit__ Some__ Fairly well__ Fluently__ (please check)
11. Can you write in a second language? No___ A bit__ Some__ Fairly well __ Fluently__ (please check)
12. I have access to a computer or tablet in the classroom. Yes__ No__
13. I have access to the Internet in the classroom. Yes__ No___
14. What type of learner are you (Check all that apply) Moving___ Building___ Reading___ Writing___ Listening___ Discussing____ Investigating____ Other_____ Not sure ____
15. What experience do you have with technology in the classroom? __ Lots __ Some ___ Little ___ None_____

Course Instructor Teaching: Circle the number that best describes your experience in the instructor phase	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
16. The historical content was presented in an engaging way	1	2	3	4	5
17. I was engaged with fellow students during class time	1	2	3	4	5
18. I was engaged with my professor during the class time	1	2	3	4	5

History Engagement: Circle the number that best describes your experience in the instructor phase	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
19. The teacher used critical inquiry to teach history	1	2	3	4	5
20. A textbook was the primary source of historical information	1	2	3	4	5
21. PowerPoint was the primary source of historical information	1	2	3	4	5
22. I found critical inquiry useful to learn about history	1	2	3	4	5
23. Primary sources were presented through text or pictures	1	2	3	4	5
24. Secondary sources were presented through text or pictures	1	2	3	4	5
25. History teaching methods as I have experienced them are relevant to the modern world	1	2	3	4	5

History Topics: Circle the number that best describes your experience in the instructor led phase	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
26. The history topic was appropriate	1	2	3	4	5
27. The history topic was challenging	1	2	3	4	5
28. The history topic was biased	1	2	3	4	5
29. The history topic was relevant to modern context	1	2	3	4	5
30. The course historical topic increased my interest in history	1	2	3	4	5
31. It increased my interest in the class	1	2	3	4	5
32. The historical topic increased engagement	1	2	3	4	5
33. The instructor's methods of teaching history are relevant to the way I learn	1	2	3	4	5
36. Historical literacy is relevant to modern society	1	2	3	4	5
37. My interpretation of the content was relevant to my learning	1	2	3	4	5

Student-Teacher Relationship Circle the number that best describes your experience during the instructor led phase	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
38. I have a good relationship with my teacher	1	2	3	4	5
39. The instructor's method of teaching increased engagement with my instructor	1	2	3	4	5
40. Having a good relationship with my teacher enhanced learning	1	2	3	4	5
41. The teacher suggests new methods of inquiry to examine history	1	2	3	4	5
42. The relationship with the instructor is important	1	2	3	4	5

Student-Student Relationships: Circle the number that best describes your experience during the instructor led phase	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
43. The instructor's teaching methods facilitate increased co-operative work relationships with other students	1	2	3	4	5
44. Having a good relationship with other students enhanced learning	1	2	3	4	5
45. Instructor educational methods made working with fellow students' easier	1	2	3	4	5
46. Instructor teaching methods increased engagement with fellow students	1	2	3	4	5
47. Working with other students increases engagement	1	2	3	4	5
48. Instructor teaching methods assisted in creating new ideas with fellow students	1	2	3	4	5

Technology Experience: Circle your level of experience using the following	None	Very Little	Some	A Lot	Extensive
49. Facebook	1	2	3	4	5
50. Twitter	1	2	3	4	5
51. Blogs	1	2	3	4	5
52. Wikis	1	2	3	4	5
53. Skype	1	2	3	4	5
54. FaceTime	1	2	3	4	5
55. Chat (instant messaging)	1	2	3	4	5
56. SMS (Texting)	1	2	3	4	5
57. Blackboard	1	2	3	4	5
58. Moodle	1	2	3	4	5
59. Titianpad	1	2	3	4	5
60. VoiceThread	1	2	3	4	5
61. ePortfolios	1	2	3	4	5
62. Virtual Reality	1	2	3	4	5
63. YouTube	1	2	3	4	5
64. Haptics (e.g., like a cellphone's keyboard)	1	2	3	4	5
65. Virtual reality (e.g., Oculus Rift)	1	2	3	4	5
66. Augmented reality (e.g., Pokémon GO)	1	2	3	4	5

Appendix B: Post-test survey

THOMPSON RIVERS UNIVERSITY

Phase 2 Survey for Participants

Research Project

File Number: 101322

Approval Date: October 25, 2016

Expiry Date: October 24, 2017

Evolve your History: Learner Engagement in the History Classroom through Augmented Reality

Principal Investigator: Lachlan Gonzales

Graduate Student

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Thompson Rivers University, Kamloops, BC V2C 0C8

Phone 250-814-3885 Email: Lachlan.Gonzales@Gmail.com

The researcher is looking to use an advanced technology in classrooms called augmented reality, a computer overlay of information on the real world, to study the engagement of history students on historical content and other areas and see if augmented reality increases said engagement. I am pleased that you have consented to be interviewed. Your feedback is important to help me understand how augmented reality effects your engagement with history content and the education of history at TRU. This will be used to potentially create an augmented reality curriculum to increase student engagement. This survey is designed to elicit information about: engagement with historical content, student-student relationships, and student-teacher relationships.

Your responses will be kept strictly confidential, no information collected can be used to identify you and you may opt out at any time without any consequences. The survey should take about fifteen (15) minutes. If the survey has been completed it will be assumed consent has been given. If you have any questions or concerns, you may contact me at the above number or email.

Thank you for participating.

==========

You will be asked to give your views on the augmented reality phase:

Augmented Reality: Circle the number that best describes your experience during the augmented reality phase	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1. Have you used augmented reality	1	2	3	4	5
2. Augmented reality enhanced my engagement with the instructor	1	2	3	4	5
3. Augmented reality enhances my engagement with the historical content	1	2	3	4	5
4. Aurasma was easy to use	1	2	3	4	5
5. Augmented reality enhanced my engagement with fellow students	1	2	3	4	5
6. Augmented Reality can be used to teach history	1	2	3	4	5
7. Augmented reality can be used in education	1	2	3	4	5
8. The photo triggers used were easy to work with	1	2	3	4	5
9. Using augmented reality would increase my learning	1	2	3	4	5

History Engagement: Circle the number that best describes your experience during the augmented reality phase	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
10. The teacher used augmented reality to teach history	1	2	3		5
11. A textbook was the primary source of historical information	1	2	3		5
12. PowerPoint was the primary source of historical information	1	2	3		5
13. I found technology useful to learn about history	1	2	3		5
14. Primary sources are presented through text or pictures	1	2	3		5
15. Secondary sources are presented through text or pictures	1	2	3		5
16. I am motivated to use technology to learn about history	1	2	3		5
17. Augmented reality teaching methods as I have experienced them are relevant to the modern world	1	2	3		5

History Topics: Circle the number that best describes your experience during the augmented reality phase	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
18. The history topic was appropriate	1	2	3	4	5
19. The history topic was challenging	1	2	3	4	5
20. The history topic was biased	1	2	3	4	5

Augmented Reality & History: Circle the number that best describes your experience during the augmented reality phase	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
21. Augmented reality can be used to present historical topics	1	2	3	4	5
22. Augmented reality made history easier to learn	1	2	3	4	5
23. Augmented reality enhanced the presented content	1	2	3	4	5
24. Augmented reality increased my engagement with history	1	2	3	4	5
25. Augmented reality allowed new ways of exploring historical content	1	2	3	4	5
26. The use of augmented reality to teach history was clearly visible	1	2	3	4	5
27. The historical content displayed through augmented reality was engaging	1	2	3	4	5
28. Text, videos and pictures were helpful in creating a picture of the historical content	1	2	3	4	5
29. Augmented reality increased my interest in the class	1	2	3	4	5

Augmented Reality Teaching Methods: Circle the number that best describes your experience during the augmented reality phase	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
30. Augmented reality technology increased engagement with the instructor	1	2	3	4	5
31. My interpretation of the content was relevant to my learning	1	2	3	4	5
32. The augmented reality teaching methods were relevant to the way I learn	1	2	3	4	5
33. Augmented reality makes historical literacy relevant to modern society	1	2	3	4	5

Student-Teacher Relationship Circle the number that best describes your experience during the augmented reality phase	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
34. I have a good relationship with my teacher	1	2	3	4	5
35. Augmented reality facilitated increased engagement between my teacher and myself	1	2	3	4	5
36. Having a good relationship with my teacher enhanced learning	1	2	3	4	5
37. Augmented reality enhanced my relationship between the teacher and myself	1	2	3	4	5
38. The relationship with the instructor is important	1	2	3	4	5

Student-Student Relationships: Circle the number that best describes your experience during the augmented reality phase	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
39. Augmented reality teaching methods facilitate increased co-operative work relationships with other students	1	2	3	4	5
40. Working with my fellow students increases engagement	1	2	3	4	5
41. Augmented reality made working together easier	1	2	3	4	5
42. Augmented reality made collaboration with fellow students more important	1	2	3	4	5
43. Working with fellow students increases engagement	1	2	3	4	5
44. Augmented reality teaching methods assisted in creating new ideas with fellow students	1	2	3	4	5

Augmented Reality: Circle the number that best describes your experience during the augmented reality class	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
45. The historical content was presented in an engaging way	1	2	3	4	5
46. I was engaged with fellow students during class time	1	2	3	4	5
47. I was engaged with my professor during the class time	1	2	3	4	5

Adapted from Walton, P. (2010)

Appendix C Interview questions for students

Interview Guide for Participants

Research Project

File Number: 101322

Approval Date: October 25, 2016

Expiry Date: October 24, 2017

Evolve your History: Learner Engagement in the History Classroom through Augmented Reality

Principal Investigator: Lachlan Gonzales

Graduate Student

Faculty of Education and Social Work

Thompson Rivers University, Kamloops, BC V2C 0C8

Phone 250-814-3885 Email: Lachlan.Gonzales@Gmail.com

The researcher is looking to use an advanced technology called augmented reality in classrooms. This will involve a computer overlay of information on the real world, to study the engagement of history students on historical content and other areas and see if augmented reality increases engagement. I am pleased that you have consented to be interviewed. Your feedback is important to help me understand how augmented reality effects your engagement with history content, your fellow students, teacher, technology, and the education of history at TRU. This will be used to potentially create an augmented reality curriculum to increase student engagement.

This interview is designed to expand on information from the survey and the classroom study. It will be audio-taped for those who have consented. Your responses will be kept strictly confidential, no information collected can be used to identify you and you may opt out at any time without any consequences. The interview should take about 20 minutes.

Background Information

Gender:

Program & Major:

History courses taken:

Length of studies at TRU:

==========

Engagement

1. Was your engagement in class based on the instructor, the content, or methods? Why?
2. Were the historical research methods used in the class enhanced by the augmented reality curriculum?
3. What made you feel engaged in this study? What detracted from the experience?

Augmented Reality

4. What do you think are the key factors that explain engagement with augmented reality apps such as Aurasma and Pokémon Go?
    a. Physical activity?
    b. Technology?
    c. Collaboration?
    d. Novelty?
    e. Other _____

5. What is it about augmented reality that is engaging to you?

6. Are there barriers to using augmented reality in the classroom?

7. Did augmented reality increase your interest in history as a subject? How?

Historical content

8. Did augmented reality increase your engagement with the historical content? How?

9. What historical topics do you believe would increase your engagement in history?

History Research Methods

10. Were the history research methods used in the class enhanced by the augmented reality?
11. Were the history research methods used in the study engaging and relevant to the way you learn?

Relationships

12. Did the augmented reality enhance your relationship with other students? How?
13. Did the augmented reality enhance your relationship with the teacher? How?

Curriculum

14. What could we do to make augmented reality in the classroom more engaging?
15. Do you have suggestion for this study?

Appendix D: Interview questions for educator

Interview Guide for Educator

Research Project

File Number: 101322

Approval Date: October 25, 2016

Expiry Date: October 24, 2017

Evolve your History: Learner Engagement in the History Classroom through Augmented Reality

Principal Investigator: Lachlan Gonzales

Graduate Student

Faculty of Education and Social Work

Thompson Rivers University, Kamloops, BC V2C 0C8

Phone 250-814-3885 Email: Lachlan.Gonzales@Gmail.com

The researcher is looking to use an advanced technology called augmented reality in classrooms. This will involve a computer overlay of information on the real world, to study the engagement of history students on historical content and other areas and see if augmented reality increases engagement. I am pleased that you have consented to be interviewed. Your feedback is important to help me understand how augmented reality effects your engagement with history content, your fellow students, teacher, technology, and the education of history at TRU. This will be used to potentially create an augmented reality curriculum to increase student engagement.

This interview is designed to expand on information from the survey and the classroom study. It will be audio-taped for those who have consented. Your responses will be kept strictly confidential, no information collected can be used to identify you and you may opt out at any time without any consequences. The interview should take about 20 minutes.

Background Information

Gender:

Faculty:

Degrees Earned:

Length of teaching at TRU:

==========

Engagement

1. Was your engagement in class based on the students, the content, or methods? Why?
2. Were the historical research methods used in the class enhanced by the augmented reality curriculum?
3. What made you feel engaged in this study? What detracted from the experience?

Augmented Reality

4. What do you think are the key factors that explain engagement with augmented reality apps such as Aurasma and Pokémon Go?
    a. Physical activity?
    b. Technology?
    c. Collaboration?
    d. Novelty?
    e. Other _____

5. What is it about augmented reality that is engaging to you?

6. Are there barriers to using augmented reality in the classroom?

7. Did augmented reality increase your interest in history as a subject? How?

Historical content

8. Do you believe augmented reality increased student engagement with the historical content? How?
9. What historical topics do you believe would increase student engagement in history?

History Research Methods

10. Were the history research methods used in the class enhanced by the augmented reality?
11. Were the history research methods used in the study engaging and relevant to modern students?
12. What are some ways you teach to appeal to their current needs?

Relationships

13. Did the augmented reality enhance your relationship with students? How?
14. Did the augmented reality enhance student relationship with the content? How?

Curriculum

15. What could we do to make augmented reality in the classroom more engaging?
16. Do you have any suggestions for this study?

Appendix E: Feedback form for students

Feedback Form for Participants

Research Project

File Number: 101322

Approval Date: October 25, 2016

Expiry Date: October 24, 2017

Evolve your History: Learner Engagement in the History Classroom through Augmented Reality

Principal Investigator: Lachlan Gonzales

Graduate Student

Faculty of Education and Social Work

Thompson Rivers University, Kamloops, BC V2C 0C8

Phone 250-814-3885 Email: Lachlan.Gonzales@Gmail.com

The researcher is looking to use an advanced technology in classrooms called augmented reality, a computer overlay of information on the real world, to study the engagement of history students on historical content and other areas and see if augmented reality increases said engagement. I am pleased that you have consented to provide feedback on this study. Your feedback is important to help me understand how augmented reality effects your engagement with history content and the education of history at TRU. This will be used to potentially create an augmented reality curriculum to increase student engagement.

This feedback will help me create a better curriculum based on your individual needs. Your responses will be kept strictly confidential, no information collected can be used to identify you and you may opt out at any time without any consequences. The feedback should take about five (5) minutes. If the feedback form has been completed it

will be assumed consent has been given. If you have any questions or concerns, you may contact me at the above number or email.

Thank you for participating.

==========

1 Do you have any suggestions on how history education could be more engaging?
2 D you have suggestions on how augmented reality could be used in education?
3 Do you have any suggestions for this study?

Appendix F: Field notes

November 7th, 2016

Phase One Field Notes- Lachlan Gonzales

Observations from the classroom 8:37 AM

Wilson starts by talking about Historians in the Digital age. At the beginning the students seem tired but attentive to what he is talking about. Wilson starts by remarking he is not sure if the students read the chapter followed by his (possibly) nervous laughter. He talks about placing students in groups followed by a very short introduction of myself and the students seem distracted by this development. He sits down with the group in a long round table and proceeds to talk about the chapter asking about specific quotes that would support the evolution of historians' in the digital age. The students start talking in quiet voices and there is the occasional laugh and higher pitched happy talk. The talk starts to die down as they begin their happy talk. The students are talking to one another and exchanging ideas. The body language observed indicates they are engaged with the subject. Wilson joins in the discussion to elicit more responses. I am too far away to discern individual conversations. The conversation drops as some students look at me. The conversations rise again. A student quotes from p 83, 3/4ths of the way down the page. – understanding decontextualized history. It is a challenge to understand the original environment. The students seem enthusiastic about learning about the historian's abilities in the digital age. Another start to talk about online cultural behaviour. Students looking to find understanding about history. Wilson switches between asking questions and telling stories to keep the student engaged in the subject matter. The students seem engaged by his stories and attentive. A student talks about historical information may not believable? the 10th century had different approaches to history.

At 8:45 students seem to lose interest in the current subject and talking about it. Wilson starts telling a story to drive student interest. Is it possible that student interest is related to the stories that teachers tell? Stories that are allegorical drive interest. They seem to listen to the professor's story with interest. There are only a few students using their phones, but they seem to be taking notes as well so by inference they could be using

their phones to search up information. They listen and take notes on what he is saying. The professor's second discussion question provokes discussion by one female student with an interesting opinion. A second female student pipes up with a response. The professor agrees and launches into another story. Is a historian a computer programmer as well? Interest is flagging. The professor asks if there is anything else? Students ask questions. He answers, and most student's attention shifts to him. Some students seem lost in thought. He ends the discussion and starts handing back an annotation assignment and the conversation starts up again. The classroom orientation is not conducive to discussions or to handing back assignments nor walking around. Perhaps a different arraignment would be better for the students. The professor remarks that everyone should sit in alphabetical order. The class gets quieter as they begin to examine their marks.

The professor comments on how impressed he is with their research and extra work that they did. Nearly everyone has received good marks. A big difference from other classes. He talks about how context is a common issue in history. They did miss relating it to the source but only the single document. They stuck with what they had but did not end up going further. Tough to tell what doc they were using. They were fun to read. A final mini assignment to hand back. Many did not talk about the book at all. The professor is lenient but still a tough marker. It seems they did not do as well as he indicated. Unsatisfactory grade. He gives a bonus assignment to make up for their bad mark. Class ends.

Phase Two Field Notes

November 14th

Five different groups. They seem energised and the weather is good, but they will mainly be inside.

Group 1

Whoa; Difficulties with the questions; Difficulties taking notes – they needed to read the whole conversation. They took longer than they thought, and some photo triggers were missing. Their interaction with the characters was a slow point.

Group 2

"It was fun" "Apps are junk" Co-operation does not seem apparent. Individualistic in evidence collection. But collective in directions and helping each other.

Group 4

Character difficulties; "This is really interesting"; Minimal co-operation; Seem to go about it with okayness Just making it work; They read the evidence individually and they are quiet. Taking longer than they thought. "Better than class"

Group 5- In class

Attentive to the professor; Completed it very quickly. Studying the evidence pieces; Did not know they could interact with the characters. Excitedly scanning the evidence, seeking answers.

Problems

Taking notes; Interacting with the characters; Difficult to read; Not as intuitive as expected; They needed more time; -App was not perfect; Crashing; Having problems with the triggers; Posters had been removed; They are not showing ardent co-operation but some collaboration to learn and understand; 1 person interviewed had done research on Richard III previously.

They were able to talk with other students that they had had no interaction with before. It was a new approach to the study of history. It got them out of the classroom. The interaction was cool. Reading the evidence aloud would have been neat. Voiced characters? A non-typical way of understanding the evidence. Clearer instructions would have helped.

Appendix G: Characters

Four characters were created for the students. They represented a variety of social classes in the medieval eras and were created to reveal or hide information from the students and make them relate on a more social level to the application and the topic.

Knight

Figure 11. Sir Daniel Edwards

The knight was made to have been once loyal to Richard but still hesitant to reveal information because of his past loyalties. He would however, reveal that he believed that King Henry was the killer, but he was not sure and would quickly cover his mistake. The information he provided would be circumspect when the participants encountered the other characters however, societies respect for the title of knight would maybe influence the participant's belief.

Priest

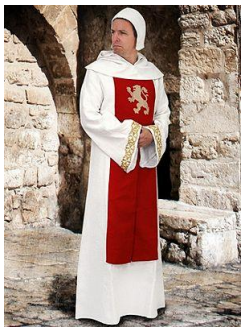

Figure 12. Franz Joseph

He was based off the real-life priest Dominic Mancini who had been in England during the time that the Princes were alleged to have been killed. This character was also hesitant to reveal information as it was not his country. Though he would respond with a more logical analysis that would point towards Henry being the killer. Due to his logical nature and the fact that he is a priest, it was believed that the participants would immediately believe his story only begin to question it if they encountered the maid and serf directly afterwards.

Maid

Figure 13. Charlotte Lyndin

The maid was modeled after a simple working woman in the fourteenth century. In this era women were largely uneducated, and they were not considered the equal of men however, her information would be largely word of mouth. The participants were expected to take note but not have any strong feelings towards the legitimacy of the information.

Serf

Figure 14. David the Serf.

The serf was based upon a working man in the fourteenth century. Uneducated and poor, his information was completely incorrect, and his believability was immediately suspect as he asked for money to refresh his memory. It was expected that the participants would disregard his information on any order of encounter.

It is noted that these characters appeared only as still images and text. As expressed by the participants, voiced and mobile characters would have been more engaging and interactive.

Appendix H: Description of historical topic

A brief history of Richard III and The Princes in the Tower

Richard the III (see Figure 9), was King of England from 1483 to 1485, his reign fraught with low public opinion and rebellions, the largest of which caused deep internal strife and led by the former King Edward IV (Ross, 1981). He was killed at the Battle of Bosworth in 1485 and his body discovered only recently in 2013.

Figure 15. Richard III, painted C.1520

The disappearance of princes Edward and George caused the origin of the Princes in the Tower legend sometime in late 1483 purportedly in the Tower of London where Richard was staying (Tey, 1951). This parked rumors that he had killed them to cement his claim to power (Pollard, 1991). At the time, there were few rumors and they only turned mainstream with the publication of Shakespeare's famous play Richard the III. Subsequent books and analyses, both historical and contemporary have been published either stating to solve the mystery, offer new leads or suspects (Kelly, 2000). Even current journals and books cannot agree on an interpretation of the tale. The Daughter of

Time, by Josephine Tey, (1951) published over fifty years ago, and considered one of the most influential mystery novels (Moody, 1990), is one such book that explores the historical evidence and attempts to rationally argue for Richard's innocence. This book was the focal point for the target classroom and the researcher drew on this book as a framework for the participant's experiment.

A Summary of Tey's Daughter of Time

Tey's novel follows inspector Allen Grant of Scotland Yard, who is recovering from an injury that leaves him critically bored. He starts studying a portrait of Richard III and concludes that based on his face, that he cannot have killed his nephews. To substantiate this claim, he studies British history focusing on accounts of Richard III, using historical research methods and logic, he postulates a pro-Richard theory. He states that it was Henry VII that killed his nephews and blamed Richard.

This book while lighthearted and an easy read, explores how history can be misread and changed, if not twisted into outright lies. For instance, Richard III was not a hunchback as Shakespeare's play would have the reader believe, though he did possess idiopathic scoliosis (Current Archaeology, 2012). Tey's book highlights the need to critically examine historical documents and arguments to arrive at a more scientific conclusion. However, this book does not solve the mystery and to date, it has not been solved.

The participants were given this topic on order to potentially develop historical literacy, engagement and assess historical content in its accuracy. Eventually concluding as to whom killed the Princes based on the evidence provided. They were not expected to find conclusive evidence nor arrive at a final empirical conclusion.