Virtual Reality in History Education: Instructional Design Considerations for Designing Authentic, Deep, and Meaningful Learning

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Abstract

Too many middle years and high school students remain disengaged from history education, often perceiving it as irrelevant to their everyday lives and futures. While teachers aspire to design engaging history lessons, achieving this goal is challenging amidst the complexities of contemporary classrooms. Differentiating instruction to meet diverse student needs while navigating outdated and rigid curriculum guides can overwhelm educators. Addressing these pedagogical concerns, we conducted a mixed-methods study with 98 participants from the University of Saskatchewan to explore how virtual reality (VR) technologies can support the training and development of pre-service teachers in history curriculum and instruction. Guided by Allen & Sites' (2012) Successive Approximation Model

(SAM), VR experiences were designed to immerse participants in two specific historical contexts: *The Ottawa River Timber Slide* and *Agnes Deans-Cameron Magic Lantern Tour*. Data collection methods included Likert scale surveys, open-ended questions, participant observations, and group debriefing sessions. The findings are synthesized within the context of the broader scholarly literature, bridging theoretical insights with practical applications. Based on the study results, we propose instructional design recommendations for integrating VR to support authentic, deep, and meaningful learning experiences in history education.

Keywords: Authentic Learning, Instructional Design, History Education, History Teaching, Teacher Training, Immersive Learning Experiences, Virtual Reality Education

Introduction: Immersive Learning Experiences in History Education

Integrating student-centred pedagogies with interactive technologies such as digital games and immersive learning experiences can be challenging for new middle-years and high school history teachers (Maloy & LaRoche, 2010; Serrano-Ausejo, 2023). Although History Departments and Teacher Education Programs introduce pre-service teachers to innovative instructional approaches and assessment methods, teachers are not sufficiently applying this knowledge in classrooms. New teachers often face overwhelming demands, balancing the pressures of covering extensive curricular outcomes across multiple subjects while attempting to address the complex needs of their students. These needs include supporting students who are gifted learners, culturally and linguistically diverse learners, neurodivergent learners, and more. Outdated curricula and resource constraints further exacerbate teacher workloads, offering limited flexibility or time for implementing active learning strategies. As a result, some new history teachers rely on text-heavy resources, rote memorization, and standardized assessments

in their history lessons, which can limit students' opportunities to engage critically with historical narratives or connect them to their personal lives and cultural contexts (Tallavaara & Rautiainen, 2020; Wiersma, 2010). This study explores how immersive technologies can support the training and development of pre-service teachers in history education. The focus is on VR as a tool to facilitate instruction that is feasible, scalable, and responsive to the challenges and opportunities of contemporary history classrooms.

The recent literature on VR in history education highlights its strengths and limitations. The motivational and engagement aspects of integrating VR in history classrooms are well-documented. For example, the study by Makransky and Mayer (2022) demonstrates the *immersion principle*, showing how VR enhances engagement and comprehension by situating students within geographical contexts rather than presenting a lesson with complex information and perspectives which many students may find challenging to interpret or contextualize. Similarly, Papadopoulou et al. (2024) report how social VR platforms can utilize immersive storytelling and interactivity to support active, student-centred learning, thereby increasing cognitive and emotional connection to sensitive historical events. Their findings align with Richards et al. (2023), who suggest that VR fosters historical empathy by enabling students to *step into the shoes* of historical figures, offering emotional and sensory experiences that other teaching methods cannot easily replicate: "The value of VR may be in its ability to arouse empathy, allowing students to learn with their minds— through their hearts" (p. 18). Similarly, Sweeney et al. (2017) demonstrate how VR allows students to explore reconstructed historical sites and observe how spaces evolved, fostering critical thinking and historical empathy.

A recurring debate in the literature is the balance between emotional engagement and cognitive learning. Richards et al. (2023) found that while VR is effective in fostering historical

empathy and student motivation for learning, it can fall short in delivering factual knowledge compared to traditional lectures. They argue that critical thinking activities should complement VR experiences so that students can question dominant historical narratives, consider alternative perspectives, and analyze historical evidence with a critical lens. Makransky and Mayer (2022) call for aligning immersive experiences with multimedia learning principles to meet emotional and cognitive learning outcomes. Petersen et al. (2020) critique the overreliance on VR's novelty factor as an engagement tool, cautioning that without a focus on inquiry and thoughtful integration into the curriculum, VR risks becoming a superficial instructional tool rather than a means for transformative learning in the history classroom. Hence, there is a need to balance VR's immersive strengths with pedagogical strategies that promote critical thinking and student inquiry— instead of entertainment or static narratives (Remolar et al., 2021). Several scholars point to the importance of instructional design in optimizing VR's impact on history education (e.g., Egea-Vivancos & Arias-Ferrer, 2021; Petersen et al., 2020; Remolar et al., 2021; Wang et al., 2024).

Although VR offers valuable opportunities for experiential learning in history lessons, resource limitations and long-term sustainability concerns often hinder its implementation in classrooms. Fransson et al. (2020) identify the prohibitive costs of VR equipment, including head-mounted displays (HMDs) and specialized applications, as well as the lack of professional development for teachers, as key obstacles to widespread adoption. Beyond the initial investment, schools face ongoing costs due to technological obsolescence and replacement of HMDs, software updates, and new program purchases. These recurring expenses can be prohibitive for schools with limited funding. Additionally, the technical requirements for the setup, operation, and troubleshooting of VR equipment further complicate its integration into

classrooms, as it can be difficult and time-consuming for teachers with limited prior experience to adapt to evolving software interfaces, all while balancing their existing instructional responsibilities (MacDowell, 2022). To address these barriers, Chrysanthakopoulou et al. (2021) call for inclusive design practices that prioritize accessibility, usability, and cultural relevance—ensuring that teachers and students across diverse settings can fully engage with the technology.

This article synthesizes the perspectives and concerns of pre-service teachers on the design and integration of immersive learning experiences for history education in middle-years and high school classrooms, offering insights into their pedagogical value and practical feasibility. As Remolar et al. (2021) argue, VR strategies "should be attractive both for the students and the teachers" (p. 396), emphasizing the dual importance of student engagement and teacher buy-in for successful implementation. Educators decide what to teach and how to deliver it, making it essential to understand their VR experiences. By reporting the first-person perspectives of pre-service teachers, this article provides an understanding of their comfort levels, confidence, and preparedness for integrating VR into history lessons. Additionally, this article explores how immersive learning experiences can impact student engagement, curiosity, and emotional connection to historical subject matter. The discussion includes the design features of VR environments that can support students in understanding the influence of the past on present events while encouraging them to imagine future realities by "thinking with history" (Green, 2012, p. 175). Based on the study's findings, this article contributes actionable instructional design recommendations for creating new possibilities to learn history through authentic, deep, meaningful, and immersive learning experiences.

The Project Partnership and Instructional Design Protocols

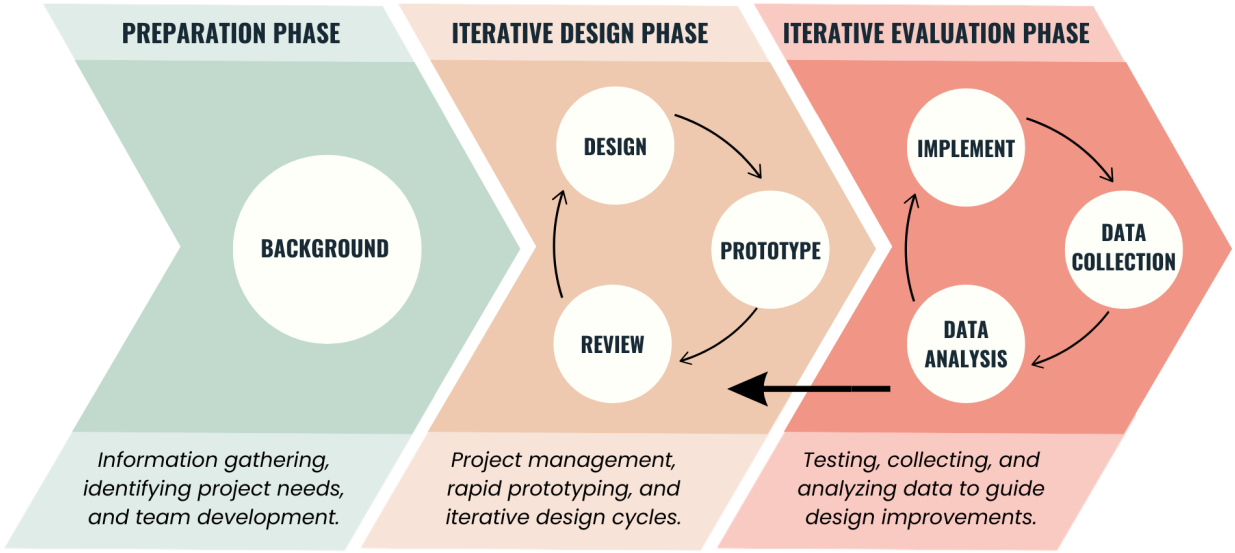
This study is part of a longitudinal project funded by a Social Sciences and Humanities Research Council of Canada (SSHRC) Partnership Development Grant focused on immersive technologies to foster historical thinking and connect historical knowledge to contemporary issues. The project aspires to engage diverse audiences, including those who may not typically read history books or visit museums. The multi-sector collaboration brings together an interdisciplinary team of academic researchers, public historians, industry developers, and heritage sector partners, including the Canadian Museum of History, the Western Development Museum, and the London Metropolitan Archive. The partnership model bridges gaps in expertise across sectors. While academic historians and heritage curators contribute extensive historical knowledge, they often lack the technical expertise required to develop fully immersive digital experiences. Conversely, private sector partners, such as UK-based Heritage 5G and Hyperactive Developments Limited, bring advanced technological capabilities but rely on historians and educators to ensure historical accuracy and pedagogical integrity in content development. The public historians involved in the project, including Clifford (2017) and Hoy (2018), are accomplished PhDs and researchers contributing their expertise in mobilizing academic knowledge to connect with the public. Two faculty members from the College of Education strengthen the collaboration by offering pedagogical expertise.

The interdisciplinary partnership consists of three specialized teams: the technical, historical, and pedagogical teams— Tables 1, 2, and 3 detail each team's key research and design milestones. Allen & Sites' (2012) *Successive Approximation Model (SAM),* guided the project's flexible and iterative design approach, enabling the teams to use rapid prototyping and participant feedback to develop, evaluate, and refine solutions (Figure 1). By documenting and sharing this process, we aim to provide a model for others to critique, replicate, and adapt to

similar initiatives. While the tables delineate distinct roles and objectives for each team, the practical realities of an iterative design process necessitated significant overlap and cross-team collaboration. During the iterative design phase, the team devoted significant time and energy to solving technical challenges, often rethinking and reworking earlier design assumptions. For instance, technical limitations often shaped decisions about historical content. This section outlines the streamlined instructional design process the project partnership utilized (Larson & Lockee, 2020). The section *Three Lessons Learned in Designing VR for History Instruction* discusses setbacks and lessons learned.

Figure 1

Successive Approximation Model for Designing and Evaluating Immersive Learning Experiences



Note. Figure 1 was developed by the authors using Canva, adapted from Allen & Sites (2012).

Stage 1. Preparation Phase

The preparation phase established a solid foundation for the project by gathering essential background information, identifying needs and challenges, and identifying factors that could support or hinder the project's progress and successful implementation. This phase included developing the interdisciplinary partnership among the technical, historical, and pedagogical teams, which included faculty members, heritage sector partners, VR developers, graduate research assistants, and one post-doctoral researcher. The partnership brought together individuals and institutions that rarely have opportunities to work together, allowing us to pool our skills, expertise, and resources toward a common goal. Team collaboration was critical for ensuring that the project integrated VR technologies effectively with accurate historical research and pedagogically sound practices. All partners participated in a one-day workshop to facilitate knowledge exchange and explore innovation in designing immersive experiences for history education. Additionally, regular team meetings were held on Zoom and in person, providing a consistent space for ongoing collaboration, idea generation, problem-solving, and detailed planning of research activities. These meetings played a crucial role in maintaining alignment across teams and addressing logistical considerations as they arose. Table 1 summarizes the key milestones and activities completed during this phase, highlighting the strategic planning and teamwork that occurred to ensure the project moved forward in a good way and was well-positioned for the timely completion of the project's research and design goals.

Table 1

Research and Design Milestones for the Preparation Phase

Team	Research and Design Milestones
Technical	▪ Fully understand the challenges, limitations, and opportunities of using VR technologies for history education. Evaluate the project requirements

	for accessibility and scalability to ensure the feasibility of VR solutions across diverse educational settings. ▪ Digitize key historical assets, including 3D scanning of artifacts, maps, photographs, paintings, and documents. To preserve the authenticity and usability of the digital reproductions, detailed metadata and narratives related to the digitized assets should be included.
Historical	▪ Conduct a thorough survey of museum collections and archives to develop a list of the top-priority historical artifacts for the Technical Team to digitize. The selections should align with the project's educational goals and objectives. ▪ Review existing research in the digital heritage sector for studies that include immersive learning environments or experiences. ▪ Analyze the findings from the literature to identify best practices and innovative approaches for implementing VR in history education. ▪ Compile lessons learned from the literature, documenting pitfalls to avoid during the prototyping and iterative design phase.
Pedagogical	▪ Identify the gap between *what is* and *what should be* for current teaching practices in history instruction at the middle years and high school levels. ▪ Confirm school partner testing sites in Saskatchewan and London for pilot testing and empirical evaluation of the VR solution's effectiveness. ▪ Work with the Technical Team to select VR platforms that are accessible, safe, and usable for children and youth. Ensure compatibility with school infrastructure and ease of use for educators.

Stage 2. Iterative Design Phase

The iterative design phase prioritized rapid prototyping through collaborative, interdisciplinary team efforts, employing cycles of designing, prototyping, and reviewing. Recognizing that no single solution could address the multi-faceted challenges in history instruction, the project adopted a flexible approach, piloting diverse strategies while integrating preliminary feedback from partners across diverse geographical locations via Zoom video conferencing. We experimented with Zappar (www.zappar.com) to design an augmented reality (AR) walking heritage tour set around the Royal Docks in east London, offering a location-based exploration of historical narratives. Next, we designed a virtual museum exhibit, *Canada Water: Building Victorian London* in Mozilla Hubs; however, this web-based VR platform was

discontinued on May 31, 2024 (www.support.mozilla.org). Hence, we pivoted to develop another virtual museum exhibit, *Millenium Mills: Feeding Edwardian London*, hosted on the Spatial platform (www.spatial.io). Building upon his expertise in designing history games, Hoy (2018) led the development of the *Homesteaders* board game, which immerses players in the human experiences of settlement in Saskatchewan during the early 1900s. While forthcoming research articles will provide in-depth analyses of these immersive learning experiences; this study focuses specifically on two 360° videos, *The Ottawa River Timber Slide* and *Agnes Deans-Cameron Magic Lantern Tour* (Clifford et al., 2024a, 2024b). Guided by the project management protocols established during the preparation phase, the iterative design process adhered to Denning's (2021) philosophy that effective history education requires more than technological novelty, emphasizing the need to blend critical thinking and deep play to foster authentic connections to historical content.

> As teachers, we must not fall into the trap of thinking that we can hack our students' brains with new technology and—*voilà!*— make history relevant. Pandering "edutainment" is not the answer. Our students are savvy enough to sniff out inauthenticity, and many professional historians would refuse anyhow. It is not our task to separate serious historical work from frivolous historical play; our task is instead to explore the potential of deep play while encouraging the critical thinking and analytical tools that will inspire broad play. (p. 198)

Table 2

Research and Design Milestones for the Iterative Design Phase

Team	Research and Design Milestones

Technical	▪ Experiment with AR, VR, and game-based learning strategies to create immersive learning experiences for history education. ▪ Engage in iterative cycles of designing, prototyping, reviewing, and refining, aiming for deep and meaningful integration of digital assets.
Historical	▪ Compile primary and secondary source research and large collections of relevant images. ▪ Write historically accurate and engaging narratives for AR, VR, and game-based learning strategies, aiming to enhance immersion and contextual understanding. ▪ Support the Pedagogical Team in conducting usability tests for preliminary immersive content and alpha versions of the 360° videos, assessing participant reactions to the experience.
Pedagogical	▪ Articulate the learning goals and objectives for each of the AR and VR environments developed by the partnership. ▪ Manage and coordinate the Technical Team's efforts to ensure the 360° videos align with curriculum standards, address diverse student needs, and support teacher training objectives.

Stage 3. Iterative Evaluation Phase

After developing prototypes and conducting initial reviews with project partners, the project moved into Stage 3, the iterative evaluation phase, where functional beta versions were tested to gather data on their educational value and limitations. This phase was essential for understanding how VR solutions perform under the dynamic conditions and distractions of real-world classrooms (Southgate, 2020). Unlike controlled lab environments, authentic classroom settings provided valuable insights into how intuitive the technology was to use, how well the 360° videos engaged participants, and whether unforeseen issues required further refinement. To expand the scope of the evaluation, the team also tested the immersive learning experiences in public outreach events held in East London during 2022 and 2023, offering additional perspectives on usability, engagement, and the overall impact. By the conclusion of the iterative evaluation phase, the project aimed to deliver classroom-ready 360° videos suitable for

integration in history lessons. Importantly, the partnership's objective was to design immersive learning experiences beyond the initial *wow factor* and facilitate "thinking with history" as a critical lens for understanding and addressing contemporary and future challenges (Green, 2012, p. 175).

Table 3

Research and Design Milestones for the Iterative Evaluation Phase

Team	Research and Design Milestones
Technical	▪ Finalize the beta versions of the 360° videos, incorporating adjustments based on feedback from the iterative design phase to address redefined learning needs and ensure educational relevance. ▪ Upload the 360° videos (English and French versions) to the Meta Quest 2 HMDs. Test their usability and compatibility using the Meta Quest TV application in VR mode. ▪ Work closely with the Historical Team to ensure the immersive quality meets the project's standards (e.g., authentic and engaging content).
Historical	▪ Provide mentorship for graduate student research assistants, offering guidance on data collection, analysis, and academic publishing to build their capacity as researchers. ▪ Work closely with the Pedagogical Team on data analysis, preparing study findings for publication in leading history and education journals..
Pedagogical	▪ Recruit participants (pre-service teachers) to empirically test the 360° videos in a classroom setting, using surveys, observations, and group debriefing sessions to collect qualitative and quantitative insights. ▪ Work closely with the Historical Team to synthesize the findings and identify areas for future educational and design improvements. ▪ Ensure all research data is managed per behavioural ethics review requirements, including secure data storage, sharing raw data only with core researchers, and publishing aggregated data or anonymized quotations to protect participants' confidentiality.

Developing the 360° Videos: Historical Accuracy and Immersive Design

Designed for viewing in VR HMDs, such as the Meta Quest TV application in VR mode, the goal of the 360° videos was to allow students to *step back into history* by placing students within two reconstructed historical events: *The Ottawa River Timber Slide* and *Agnes Deans Cameron's Magic Lantern Tour* (Clifford et al., 2024a; 2024b). The 360° video format was chosen because it meets key project priorities: accessibility, affordability, authenticity, and student autonomy. Unlike traditional video formats, 360° video immerses students within the historical scene, giving them the agency to control their orientation and viewing direction. Further, 360° video is a user-friendly entry point for educators and students unfamiliar with more technically demanding VR systems while still delivering a deep and meaningful immersive experience (Lampropoulos et al., 2021; Mystakidis et al., 2021a).

To balance engagement with cognitive capacity, the duration of the 360° videos was limited to 3 to 5 minutes. We chose a concise format to minimize cognitive overload and ensure students could fully absorb essential historical information through immersive storytelling (Makransky & Mayer, 2022). Another design objective was to leverage VR's unique sense of presence—what Slater (2018) describes as the illusion of presence or *sense of being there.* The aim was for students to feel as though they were transported back in time. Audio narration played a pivotal role in augmenting the immersive quality of the learning experience. Drawing inspiration from museum audio tours, podcasts, and historical documentary storytelling, we crafted audio scripts that distilled key historical analyses into concise, engaging narratives. Insights gained from earlier experiments with Zappar AR highlighted the effectiveness of short, well-scripted audio in communicating historical interpretation. The following descriptions of the two 360° videos demonstrate how the teams worked together to use historical photographs, illustrations, and documents to reconstruct critical events from the past.

The Wrights' Timber Slide and Timber Colonialism in the Ottawa Valley

In developing the 360° video for *The Ottawa River Timber Slide* (Clifford et al., 2024a), two specific black and white photographs were used as primary visual references ("Timber Slide Chaudiere Falls," 1890; "Timber Slide," 1901). These historical images informed the reconstruction of the timber rafts, the dimensions of the timber slides and their downward chutes, and their geographic location with respect to notable Ottawa landmarks, such as the Parliament Library building (Figure 2). We aimed to build a historically accurate and contextually rich environment by incorporating these details. A key design decision was to incorporate a rapid descent along the downward part of the timber chutes to create the feeling of moving down the slide as a visceral experience that the student would remember. This dynamic experience replicated the physical sensation of riding a timber raft through a canal that bypassed the rapids in Ottawa. The intention was to leave students with a memorable experience of the physical challenges and ingenuity associated with the timber trade in the Ottawa Valley.

Figure 2

Original Source Photographs and Screenshots From the 360° Video

Note. Figure 2 includes "Timber Slide Chaudiere Falls," 1890, "Timber Slide," 1901, and screenshots from *The Ottawa River Timber Slide* (Clifford et al., 2024a).

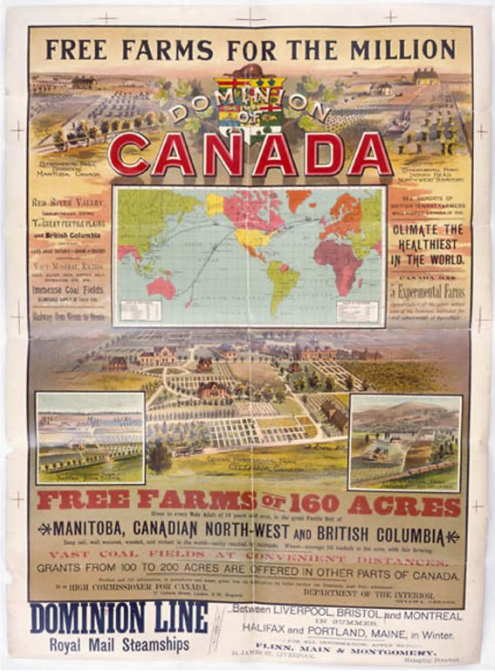
Agnes Deans Cameron's Magic Lantern and Settler Colonialism on the Canadian Prairies

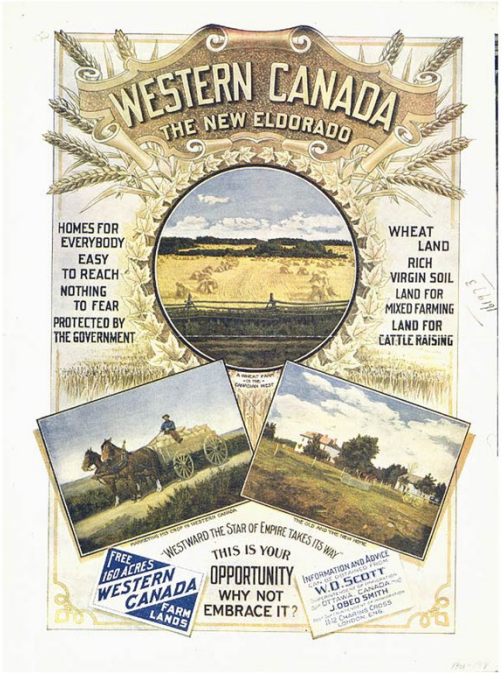
The 360° video for *Agnes Deans Cameron's Magic Lantern Tour* (Clifford et al., 2024b) was developed in partnership with the Canadian Museum of History. Central to the design process was a lidar scan of Cameron's original magic lantern, a key historical artifact from her 1901-1911 promotional campaign, *The West as Promised Land* (Canadian Museum of History, n.d.). This precise digital rendering enabled the team to recreate one of Cameron's recruitment shows held in England in 1910, where she presented a series of hand-tinted magic lantern slides. Cameron was a prominent figure in public lecture programs promoting immigration to Canada from the United States and Great Britain. These federally supported initiatives combined lectures with captivating visual aids, such as magic lantern slides, to create a compelling narrative about

the opportunities available in Western Canada. The campaign sought to attract settlers to the prairies, presenting an idealized vision of prosperity and land ownership while omitting the perspectives and realities of Indigenous peoples whose lands were being colonized (Figure 3). The primary goal of the 360° video was to provide students with an authentic and immersive experience of what it might have been like to attend one of Cameron's recruitment shows. By combining historically accurate visual and auditory elements with Cameron's persuasive rhetoric, the recreated environment evoked the atmosphere of a 1910 lecture hall. By placing the student in the audience, the 360° video sought to bridge historical understanding with emotional engagement, offering a firsthand experience of the persuasive techniques used to promote settler colonialism on the Canadian Prairies.

Figure 3

Historical Artifacts Included in the 360° Video





Note. Figure 3 includes historical artifacts from the Library and Archives Canada (1893, 1908).

Research Design and Methods

This study employed mixed methods to explore pre-service teachers' perspectives and experiences with using immersive technologies to enhance history curriculum and instruction in middle-years and high-school classrooms. The mixed method approach was chosen to provide quantitative insights and qualitative depth, allowing us to "describe and explain the issues, in the language chosen by the participants, at a greater depth so that you understand not only the rates of certain behaviours but the experience, motivation, and context" (Leavy, 2017, p. 20). We conducted the study with one third-year and two fourth-year undergraduate classes in the College of Education at the University of Saskatchewan. A total of 98 participants engaged in the research activities outlined in Table 4, ensuring a balance between individual reflection and group interaction. Of these, 70 participants completed the Likert scale survey (Appendix A), resulting in a 71% participant response rate. All aspects of the study adhered to established research ethics protocols including obtaining informed consent from participants, clearly outlining the study procedures and potential risks, and maintaining participant confidentiality throughout the data analysis and reporting of findings. The study design sought to benefit both researchers and pre-service teachers, aiming to generate meaningful data on immersive education while offering participants hands-on experience with innovative history instruction methods.

Table 4

Outline of the Research Activities

Time	Activity
15 minutes	**Demonstration and Consent**: Participants learned how to adjust the Meta Quest HMDs for a comfortable fit. The study procedures and any potential risks were explained, and informed consent was obtained from all participants.

30 minutes	**Immersive Engagement**: Participants were grouped in pairs to explore the 360° videos (*The Ottawa River Timber Slide* and *Agnes Deans-Cameron Magic Lantern Tour*) using the Meta Quest TV application in VR mode.
15 minutes	**Survey Completion**: Participants individually completed Likert scale surveys and open-ended questions to capture their experiences and perceptions of the immersive learning activities (Appendix A).
25 minutes	**Group Debrief**: The Pedagogical Team facilitated a group discussion, allowing the participants to reflect on and share their thoughts about the design and educational value of the 360° videos. The discussion provided rich qualitative insights into the effectiveness of the VR experiences.
5 minutes	**Closure and Appreciation**: The session concluded with closing remarks, and each participant received a special pen as a token of appreciation for participating in the study.

Data collection methods included Likert scale surveys, open-ended questions, participant observations, and group debriefing sessions. The qualitative data captured descriptive narratives of the pre-service teachers' reflections on using VR as a pedagogical tool in history education. The quantitative data offered measurable insights into the effectiveness of VR as a strategy for enhancing engagement, comprehension, and emotional connection to historical subject matter. NVivo was used to organize and code the data for qualitative data analysis. Thematic analysis was employed to identify recurring patterns, themes, and insights, enabling a meaningful interpretation of the participants' individual and collective experiences (Leavy, 2017). Quantitative data was analyzed using Python for statistical analysis and visualization of the survey responses. The study employed data triangulation to build confidence in the analysis of findings and ensure the trustworthiness of the results. The triangulation process involved cross-referencing data from multiple sources, including surveys, observations, and group debriefings, to verify findings, reduce biases, and identify recurring patterns. As Leavy (2017) notes, triangulation serves as a valuable tool for interpreting data by encouraging researchers to "look

for patterns across your data, make note of anomalous data, and look for links between different categories, concepts, and/or themes" (p. 152).

Through this iterative and systematic methodological approach, four key themes emerged: designing authentic VR learning experiences, facilitating comprehension and connection to historical topics through VR, assessing confidence and comfort levels with VR, and reimagining history teaching with VR. These themes are analyzed and discussed in the next section. Notably, the results are situated within the context of the broader scholarly literature, ensuring meaningful connections between theory and practice. This synthesis allowed for a more nuanced and holistic understanding of the findings, advancing theoretical knowledge and practical applications for integrating immersive technologies into history education.

Analysis and Discussion of Findings

The study findings indicate that pre-service teachers recognize the value of VR in facilitating authentic, deep, and meaningful learning experiences in history education. Overall, the 360° videos explored in this study were effective in enhancing comprehension of complex historical concepts, fostering emotional and intellectual connections to subject matter, and sparking curiosity for deeper exploration of the curriculum. These results align with existing research demonstrating the pedagogical potential of VR to bring historical events to life, making them tangible, relatable, and fun for students (e.g., Egea-Vivancos et al., 2021; Hutson & Olsen, 2022; Mystakidis et al., 2021a; Papadopoulou et al., 2024). While the study presents the educational affordances of VR when implemented with intentional design, it also brings forth instructional challenges related to issues of resource allocation, accessibility, and the need for ongoing technology training and support for teachers (Fransson et al., 2020; Southgate, 2020).

Table 5 provides an overview of the survey responses (Appendix A). To provide a trustworthy and nuanced interpretation of the study findings, the data is analyzed alongside the recent scholarly literature and organized around four interconnected themes:

1. Designing authentic and engaging VR experiences for history education.
2. Facilitating comprehension and connection to historical topics through VR.
3. Assessing pre-service teachers' confidence and comfort levels with VR.
4. Reimagining history teaching with VR.

Table 5

Overview of the Likert Scale Survey Responses

Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. The VR experience provided an authentic representation of historical events.	**0%**	**1.4%**	**8.6%**	**35.7%**	**54.3%**
2. The VR experience was engaging and held my attention.	**0%**	**0%**	**5.8%**	**29%**	**65.2%**
3. I felt immersed in the VR learning environment.	**0%**	**1.4%**	**4.3%**	**40%**	**53.9%**
4. The VR experience made complex historical concepts easier to understand.	**0%**	**0%**	**11.4%**	**35.7%**	**52.4%**
5. The VR experience helped me connect more deeply with the topic.	**0%**	**0%**	**15.7%**	**40%**	**44.3%**
6. I felt confident using the VR technology (e.g., it was user-friendly).	**0%**	**7.1%**	**28.6%**	**42.9%**	**21%**
7. I felt nauseous or uncomfortable during the VR experience.	**16.7%**	**21.4%**	**25.7%**	**27.1%**	**8.6%**
8. I would use VR to help my future students learn complex historical concepts.	**1.4%**	**4.3%**	**5.8%**	**46.4%**	**41.6%**
9. VR can support deep and meaningful learning experiences in history education.	**0%**	**1.5%**	**7.4%**	**41.2%**	**49%**
10. The VR experience would spark my students' curiosity to further explore history topics of their interest.	**0%**	**0%**	**4.5%**	**29.9%**	**65.7%**

Note. Table 5 shows the distribution of Likert scale responses across the ten survey items. Python version 3.11.3 was used to compute the values.

Designing Authentic and Engaging Virtual Reality Experiences for History Education

Authentic Representation: When responding to the statement, "The VR experience provided an authentic representation of historical events," most participants (90.0%) agreed or strongly agreed, with only 10.0% selecting other options (Table 5). Field notes recorded during the study consistently reflect the participants' favourable view of VR's potential for "shifting time and space" to create authentic and memorable learning of history lessons. One participant described how they were "genuinely experiencing history in real-time," emphasizing the impact of the VR's multi-sensory integration, combining high-fidelity visuals and narrative storytelling to create a memorable and believable historical context. This finding aligns with Slater's (2018) concept of presence, referring to the *illusion of being there*, which appears to have been a key factor contributing to participants' perceptions of authenticity. The pre-service teachers expressed an appreciation for how VR provided a "new dimension to their teaching methods," providing an instructional tool that aligns with the interactive and visually rich media environments familiar to today's students. While wearing the Meta Quest HMDs, many participants discussed with nearby peers (unsolicited comments) how little time it took to "make the learning come to life" in VR due to being immediately immersed in the story, with the freedom to look around, observe historical details, and listen to the context-specific audio. These multi-sensory learning experiences are hard to replicate with traditional instructional methods and likely contributed to the pre-service teachers' strong perceptions of authentic representation (Lowell & Tagare, 2022; Richards et al., 2023).

Immersive Engagement: Most pre-service teachers found the history VR experience engaging; 94.2% agreed or strongly agreed that VR held their attention in the university

classroom setting. The low standard deviation (*SD=0.6*) indicates strong participant consensus (Table 5). Qualitative feedback added depth to help explain this finding, with participants reflecting on how VR allowed them to explore history in an environment where they were "more engaged personally, with no distractions," suggesting that a specific advantage of VR, compared to viewing videos, is that the HMD makes it impossible to have divided attention. Comments such as "the visuals deepened my learning experience" and "the atmosphere was conveyed like never before" highlight the unique capacity of VR to evoke a sense of place and presence that can enhance learning outcomes. Several pre-service teachers reported "superior in engagement," suggesting VR can capture attention and foster sustained engagement for some participants in ways that passive learning methods may not (e.g., listening to lectures or completing worksheets). These findings align with research by Petersen et al. (2020), emphasizing the role of engagement and focused attention for students to think critically about historical subject matter. Furthermore, Papadopoulou et al. (2024) discuss how immersive storytelling in VR can facilitate engagement in learning about sensitive and complex historical events, reflected by pre-service teacher comments describing how VR can "give students otherwise impossible experiences" within contemporary classroom settings.

Sense of Immersion: The ratings for immersion demonstrated a favourable response, with 93.9% of participants indicating agreement or strong agreement with the statement, "I felt immersed in the VR learning environment." Only a few (5.7%) selected neutral or lower ratings, with the consensus among participants reflected by a low standard deviation (*SD=0.6*) (Table 5). Qualitative insights provide additional depth for understanding how "the history came alive" in the VR environment, with participants declaring, "It felt like I was the one rowing the raft" and "I enjoyed learning while exploring." These reflections suggest that VR created an embodied

sense of presence, a state where participants felt like they were situated within the virtual historical environment (Slater, 2018). Other participants noted, "I felt like I was actually there while learning about the history," and "VR has better immersion than lectures." These statements highlight an important paradox within VR learning experiences: while the content delivery was fundamentally linear, the immersive design masked this linearity, creating an illusion of agency and exploration. These findings demonstrate how carefully designed VR environments can effectively balance structured learning objectives with the perception of open-ended exploration, giving students the impression of active participation in historical events despite following a predetermined narrative path. Furthermore, the illusion of agency within a linear narrative suggests that well-designed VR experiences can make even pre-scripted content feel interactive and personalized (Villena Taranilla et al., 2019). These findings are consistent with Makransky and Mayer's (2022) research focusing on the *immersion principle* in multimedia learning, which suggests that integrating VR environments into lessons enhances educational outcomes (in comparison to other pedagogical approaches) by situating students within the content.

Facilitating Comprehension and Connection to Historical Topics Through Virtual Reality

Understanding Historical Concept: In response to the statement, "The VR experience made complex historical concepts easier to understand," 88.1% of the pre-service teachers agreed or strongly agreed (Table 5). The minority (11.4%) who expressed neutrality or disagreement may reflect individual differences in technological fluency, prior experience with VR, or personal preferences for learning modalities (Mystakidis et al., 2021b). These quantitative findings suggest that VR, as a pedagogical tool, can help to make abstract historical concepts tangible and accessible. As one pre-service teacher responded, "This form of learning gives students the opportunity to actually see what they are learning about, which makes it so much

more exciting." A few pre-service teachers observed how VR deepens comprehension of complex historical subject matter by situating them within reconstructed historical events. For instance, Papadopoulou et al. (2020) examined how social VR was used to teach students about the Asia Minor Catastrophe, a sensitive event in Greek history "often overlooked or marginalized in history education to avoid conflicts," and found that VR facilitated historical empathy and motivated students to "actively participate in preventing such tragedies from repeating in the future" (p. 5). These findings align with MacDowell's (2023) research, which highlights how immersive learning environments can deepen understanding of the complexities and historical implications of environmental and sustainability education. Furthermore, immersive education's benefits extend beyond classroom settings. In museum contexts, for example, Wang et al. (2024) present abstract subject matter in ways that are tangible and applicable.

Connecting to Historical Topics: Participants responded positively to the statement, "The VR experience helped me connect more deeply with the topic," with 84.3% agreeing or strongly agreeing that VR fostered a deeper connection to the history lesson (Table 5). However, 15.7% expressed neutrality or disagreement, pointing to variability in how pre-service teachers perceive immersive education. One described VR as a "blend of kinesthetic and visual learning," which facilitates a sense of connection and curiosity about the topic. Qualitative feedback such as "It's good to experience learning in a standing position rather than just sitting and watching a video" and "VR helped me experience a deeper connection to the topic" suggest how VR can transform history education and be advantageous for disengaged students. The pre-service teachers reflected that history education is more than the curriculum content delivered— it is also about how the students *feel* about their learning. These findings resonate with Sweeney et al. (2018), who report VR's capacity to combine physical involvement and emotional engagement

through relatable stories that students can explore, allowing students to become active participants in their history education. However, not all pre-service teachers experienced these benefits. Some noted that discomfort or lack of confidence with VR technology prevented them from connecting deeply with or relating to the material. Hence, the integration of VR should not replace passive learning approaches but rather complement them (Remolar et al., 2021). As Mystakidis et al. (2021b) advise, there is no one-size-fits-all instructional approach; instead, the goal is to find meaningful ways to keep the learning relevant and facilitate personal connections to the historical information.

Pedagogical Considerations: Despite VR's unique affordances for helping students comprehend and connect to history topics, the pre-service teachers raised pedagogical considerations regarding resource allocation, accessibility, and the scalability of immersive learning experiences. Dede (2009) emphasizes the importance of determining the optimal level of immersion required to maintain a student's "suspension of disbelief that she or he is inside a digitally enhanced setting" (p. 66) without overwhelming their cognitive or emotional capacity. While impactful, high levels of immersion and realism must be balanced against the practical realities and feasibility of implementation in diverse educational contexts. Creating high-quality immersive learning experiences requires a significant investment of time, expertise, and financial resources (Fransson et al., 2020; MacDowell & Lock, 2022). Factors such as technical support, teacher training, privacy, safety, and barriers to access require careful attention and a long-term vision to ensure that the benefit of immersive learning can be inclusive and adaptable to varying classroom needs (Southgate et al., 2019; Southgate, 2020). Another area of concern discussed is the duration of VR sessions. Some pre-service teachers noted that immersive learning requires

significant concentration, raising questions about the appropriate amount of time students should spend in VR environments to maximize benefits without causing cognitive overload and fatigue.

Assessing Pre-Service Teachers' Confidence and Comfort Levels with Virtual Reality

Technological Confidence: Confidence in using VR technology was moderate; the pre-service teachers reported variance in their responses to the statement, "I felt confident using the VR technology" (Table 5). 63.9% of participants agreed or strongly agreed with feeling confident, while 35.7% rated using VR technology as neutral or not user-friendly. These mixed responses, with a mean rating of 3.8 (SD = 0.9), suggest that pre-service teachers could benefit from continuing professional development with VR technology. Qualitative feedback highlighted how exposure to VR positively influenced the participants' confidence to integrate VR into history education. Many participants reported "improved confidence using tech with students" and felt "excited by the possibilities of tech use" to innovate and improve their teaching practices. Several comments emphasized an "expanded understanding of how VR enhances learning," with participants noting that VR "facilitates positive experiences with technology" and deepens their comprehension of "how technology is changing and modifying education." These reflections align with findings from studies by Fransson et al. (2020) and Mystakidis et al. (2021a), who report that while VR use requires a learning curve for teachers, it offers a valuable platform for gaining practical experience with technology-enhanced pedagogies and methods to enhance learning in digital environments.

Technological Comfort: Approximately one-third of participants (35.7%) agreed or strongly agreed that they felt nauseous or uncomfortable during the VR experience, while 63.8% selected neutral, disagree, or strongly disagree (Table 5). Responses to this item varied, with a mean score of 2.9 (SD = 1.2). While some participants experienced discomfort or physical

challenges, many did not report adverse effects. These findings are important considerations for determining the feasibility of VR in classroom settings. Chang et al. (2022) reviewed the causes of VR motion sickness, identifying key factors such as hardware limitations, content design, and individual differences. Their findings indicate that advancements in VR technology will help mitigate discomfort, thereby improving its usability in educational contexts. Southgate (2020) explored VR implementation in secondary school classrooms and emphasized the importance of gradual exposure and the availability of alternative learning activities to accommodate students who may be sensitive to VR-related discomforts. Similarly, MacDowell's (2023) research involving adolescents learning in VR reports strategies for integrating immersive education to minimize discomfort for students, helping to ensure that VR remains an inclusive and accessible tool for experiential learning. In this study, participants who felt nauseous still reported high engagement and positive learning experiences, suggesting that the overall educational value of VR was not significantly diminished by temporary physical discomfort. This finding indicates that while physical side effects remain a concern, they do not necessarily undermine the pedagogical benefits of well-designed VR experiences.

Reimagining History Teaching with Virtual Reality

Learning Historical Concepts: Many of the pre-service teachers (88%) agreed or strongly agreed with the statement, "I would use VR to help my future students learn complex historical concepts" (Table 5). Qualitative responses highlighted VR's unique strengths compared to passive teaching methods, especially for visual and hands-on learning experiences, with numerous participants reporting "superior engagement" and an "expanded understanding of how to engage students in history." Some of the pre-service teachers discussed how VR can

make learning fun and enjoyable, which can contribute to a positive classroom environment. The minority (11.5%) expressed neutrality or disagreement, with one participant suggesting that the high engagement could be partly due to VR's novelty and were unsure if students in VR "actually learned more than other methods." We concur with Makransky & Mayer (2022) that the novelty or wow factor must be considered. One pre-service teacher recommended using VR as the lesson introduction to generate curiosity, interest, and empathy for history— to complement activities that develop the critical thinking necessary for an accurate understanding of historical events and narratives, including questioning assumptions, examining dominant narratives, and considering power structures (Karn, 2023; Villena Taranilla et al., 2019).

Deep and Meaningful Learning: In response to the statement, "VR can support deep and meaningful learning experiences in history education," 90.2% of participants reported agreement or strong agreement; only 8.9% chose neutral or lower ratings, underscoring a strong endorsement of VR's potential to facilitate meaningful learning experiences in history lessons (Table 5). Scholars like Mystakidis et al. (2021b) argue that deep and meaningful learning should be an essential outcome of all quality education, advocating for more longitudinal research to develop assessments that measure higher-order critical thinking skills and long-term retention rather than basic recall of facts and information. In the qualitative feedback, several pre-service teachers described VR as a "way of experiencing learning outside the classroom," making "experiential learning more accessible and sensory-driven" and offering students new perspectives on historical content. Some highlighted that VR allows students to "experience content firsthand," allowing them to engage with historical contexts in a memorable way. However, a few participants felt VR could be "overstimulating and hard to follow," with one teacher suggesting they prefer using more teacher-centred methods, even though they

acknowledge VR benefits some students. These varied perspectives suggest that while VR's effectiveness in history education may depend on the individual student's needs and teacher preferences, highlighting the importance of considering student readiness, availability of resources, and technical support for teachers (Fransson et al., 2020; Hutson & Olson, 2022).

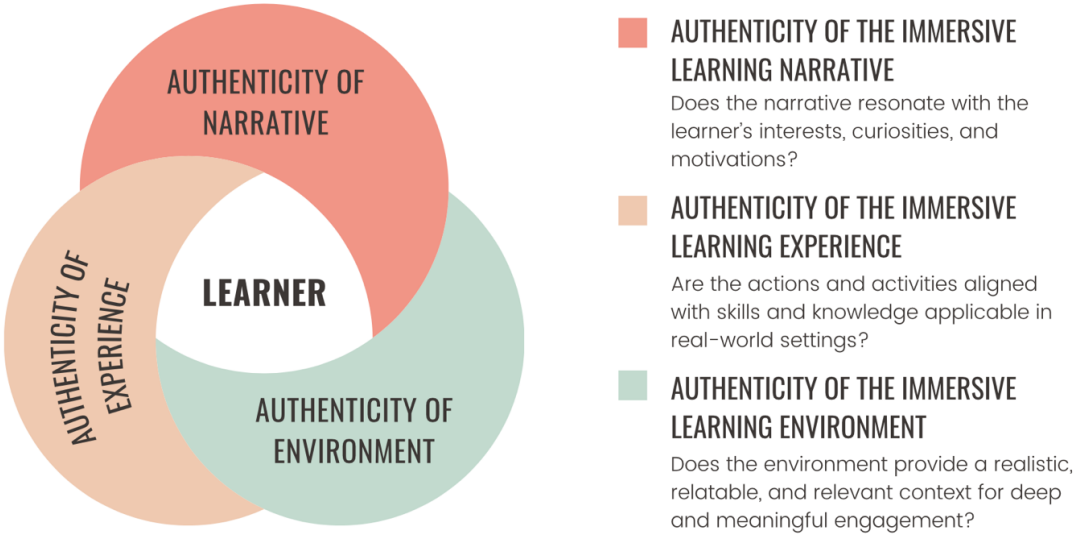
Sparking Curiosity and Exploration: The majority of participants (95.6%) agreed or strongly agreed that VR would spark students' curiosity and encourage further exploration of historical topics of personal interest (Table 5). This high level of agreement, paired with low variance (*SD*=0.57), reflects a strong consensus among the pre-service teachers regarding VR's effectiveness in fostering intrinsic motivation and curiosity to delve deeper into history. Feedback from the open-ended questions described VR as an "adaptive, exciting, and different" form of learning capable of sustaining students' interest and empowering them to actively explore history subject matter. This finding aligns with Karn's (2023) assertion that "students need to care about the past and how it impacts the present and future" (pp. 99–100), highlighting the role of teachers in designing history lessons that engage minds, generate curiosity, and cultivate empathy. VR's ability to immerse students within historical contexts positions it as a uniquely powerful tool for enabling students to experience historical settings and narratives firsthand, potentially leading to a long-term interest in historical study. As one participant remarked, VR learning experiences can make students eager to learn more by giving them "the opportunity to actually see what they are learning about, which makes history so much more exciting." To put this another way, as Richards et al. (2020) explain, "the greater sense of connection with the past that is provided by VR experiences can translate into a better understanding of the lived experiences of that time period" (p. 18).

Design Recommendations for Immersive Learning in History Classrooms

Grounded by the findings from this study, we propose a framework for designing VR-enhanced history instruction that emphasizes authenticity across three interconnected dimensions: the immersive learning narrative, the immersive learning experience, and the immersive learning environment (Figure 4). Student-centered learning is at the core of this framework, highlighting the importance of creating instruction that invites students to explore, inquire, and interact with historical content in ways that capture their attention and spark their curiosity. Further, VR strategies must balance pedagogical innovation with practical implementation, ensuring they are scalable, accessible, and manageable for educators who are tasked with integrating them into established curricular frameworks (Remolar et al., 2021). The recommendations provided in Table 6 offer guidance for researchers, designers, and educators to facilitate the design and integration of 360° videos in history classrooms.

Figure 4

Facilitating Student-Centered Learning Experiences in Immersive Education



Note. Figure 4 was developed by the authors using Canva.

Table 6

Recommendations for Designing and Integrating 360° Videos in History Classrooms

Historically Accurate Storytelling	▪ Foster collaboration among designers, historians, and educators to ensure the narratives are based on primary sources and verified historical accounts. ▪ Integrate the narrative with historical artifacts, soundscapes, signage, and props to enrich the storytelling and guide students toward historical thinking.
Emotional and Cognitive Engagement	▪ Design narratives that create emotional connections while prompting critical thinking, reflection, and historical analysis. ▪ Develop narrative arcs that maintain historical integrity, avoiding sensationalism or oversimplification of complex historical events.
Contextual Relevance	▪ Use archival resources (e.g., photographs, maps, lidar scans, and primary sources) to ensure authentic representation and historical accuracy in virtual recreations. ▪ Situate the VR environment within broader historical, cultural, and social contexts to highlight the interconnectedness of historical events and their long-term consequences.
Comfort and Accessibility	▪ Mitigate physical discomfort (e.g., VR motion sickness, HMD fatigue) through orientation sessions and ongoing tech support. ▪ Ensure cross-platform accessibility, allowing students to interact with VR content via desktop browsers, mobile devices, and HMDs. Provide offline access options where possible.
Curriculum Alignment	▪ Develop VR environments that are technically feasible and pedagogically adaptable across a range of classroom settings, age groups, and curriculum standards. ▪ Integrate VR environments into more extensive lesson plans, using them to provoke deeper exploration of historical topics through reflection prompts, debates, or group discussions.

Three Lessons Learned in Designing VR for History Instruction

Balancing Technological Simplicity with Educational Impact

One key takeaway from this project is the value of simplicity in VR design for educational purposes. While initial ambitions included responsive and interactive scenarios, we ended up compromising our goals due to the technological limitations in the VR platforms we

explored (e.g., Mozilla Hubs, Spatial, and Zappar). Despite these technical setbacks, the outcomes revealed that simple but thoughtfully designed 360° videos can deliver meaningful educational benefits. The combination of well-executed visual storytelling, narration, soundscapes, and a deliberate sense of presence proved sufficient to engage students and facilitate deeper historical understanding. These findings suggest expensive and time-consuming technological designs may not always be essential for impactful VR-based instruction. 360° videos are far less work to produce, manageable in scope, narratively compelling, and easily adaptable to diverse classroom contexts.

The Critical Role of Sound in Immersive Storytelling

Another key takeaway is that designers and educators can face all kinds of technical barriers and make all kinds of mistakes; however, if they can get the sound and the storytelling right, the immersive experience will still be impactful and educational. Sound emerged as an unexpectedly vital component of the 360° videos, serving as the narrative thread that guided learners through historical content, fostered engagement, and provided essential context. For example, *The Ottawa River Timber Slide* was essentially a linear experience, yet the guiding voiceover and soundscapes elevated its overall impact, immersing participants in the historical setting. Similarly, the *Agnes Deans Cameron Magic Lantern Tour* could have functioned as a series of images with a written script— yet the addition of narrated storytelling and character voices transformed the static visuals into an engaging, immersive journey. Future VR projects in education should prioritize high-quality audio production, recognizing that well-crafted narratives can compensate for technological shortcomings and maintain the integrity of the immersive experience, even in less interactive formats.

The Role of Facilitation and VR Troubleshooting in Classroom Success

The third key takeaway from this study is the influence of the facilitator on the success of VR-based learning experiences. In our study, the facilitators' enthusiasm, confidence, and familiarity with both the historical context and VR technology played a pivotal role in guiding pre-service teachers through the immersive experiences, fostering a learning environment where it was comfortable to ask questions and express opinions. Equally important, yet often overlooked, is the unique challenge of technical troubleshooting in VR sessions. Unlike traditional classroom technologies, troubleshooting VR involves a distinct visual barrier: the facilitator cannot directly see what students are experiencing within their HMDs. The visual barrier makes it challenging to diagnose and resolve technical issues efficiently, potentially leading to delays and frustration that can disrupt the flow of learning. Ultimately, the successful integration of VR into history education relies not solely on the technology itself but also on the human element— skilled facilitators who have the pedagogical and technical expertise to ensure seamless integration of VR into classroom instruction.

Study Limitations

Despite the study's contributions, several limitations must be acknowledged. First, the sample size was limited to 98 pre-service teachers from three undergraduate classes at a single institution, which may constrain the generalizability of the findings to broader educational contexts. Second, the study relied heavily on self-reported data gathered through surveys, open-ended questions, and group debriefing sessions. While these methods provide valuable qualitative and quantitative insights, they are inherently subject to participant bias, selective memory, and social desirability effects (Leavy, 2017). Additionally, the relatively short duration

of the VR experience limited our ability to assess the long-term impacts of immersive learning on historical understanding, knowledge retention, and knowledge transfer.

Future Research

Future research should delve deeper into the specific design elements of VR experiences that most significantly contribute to immersion and educational impact. While this study underscores the potential for immersive learning in history classrooms, the distinct contributions of visual fidelity, narrative design, soundscapes, enclosed headsets, and user interactivity remain underexplored. Comparative studies isolating and evaluating these elements could offer valuable insights into which factors most strongly influence cognitive engagement, emotional resonance, and overall learning outcomes. Identifying the design aspects that yield the most substantial educational benefits—and distinguishing them from those with comparatively minor impacts—would provide evidence-based guidance for future innovation and resource allocation in VR-based history instruction. For example, after completing our study, we wondered whether replacing current voice actors with professional narrators would significantly enhance the immersive quality or educational effectiveness of VR experiences.

Equally critical is the need for future studies with pre-service teachers across multiple institutions and geographic locations to better understand how VR can function as a pedagogical tool to support the training and development of history instructors. Longitudinal studies tracking teachers' evolving proficiency and comfort with VR tools and the resulting student experiences could uncover key enablers and barriers to sustainable VR integration in history classrooms.

Conclusion

This study highlights the potential of VR as a pedagogical tool to enhance history curriculum and instruction. By situating pre-service teachers within reconstructed historical environments, they could experience historical narratives in ways that fostered meaningful connections, authentic learning, and deep engagement. The findings demonstrate how VR can simplify complex historical concepts, create a heightened sense of presence, and spark genuine curiosity, making history education a memorable and relatable experience. However, educators must intentionally integrate VR into classroom settings, ensuring the technology supports pedagogical goals rather than acting as a superficial source of passive entertainment. The design recommendations outlined in this study—focused on authenticity in narrative, experience, and environment—provide an actionable framework for researchers, designers, and educators to integrate immersive learning in history lessons.

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Appendix A

Pre-service Teachers' Perspectives on the Impact of VR on Student Learning in History Education

This survey aims to gather your insights as pre-service teachers on how VR impacts student learning, specifically in history education. Your feedback will help us understand VR's role in developing immersive learning experiences for history students. Please respond to the statements below, considering your recent VR experience.

1 Strongly Disagree	**2** Disagree	**3** Neutral	**4** Agree	**5** Strongly Agree

Question	**Rating**
1. The VR experience provided an authentic representation of historical events.	
2. The VR experience was engaging and held my attention.	
3. I felt immersed in the VR learning environment.	
4. The VR experience made complex historical concepts easier to understand.	
5. The VR experience helped me connect more deeply with the topic.	
6. I felt confident using the VR technology (e.g., it was user-friendly).	
7. I felt nauseous or uncomfortable during the VR experience.	
8. I would use VR to help my future students learn complex historical concepts.	
9. VR can support deep and meaningful learning experiences in history education.	
10. The VR experience would spark my students' curiosity to further explore history topics of their interest.	

Open-Ended Questions

1. How did the VR learning experience contribute to your training and development as a pre-service teacher? Please provide specific examples or skills you gained.

2. How did the VR learning experience compare to other methods (e.g., lectures, videos, textbooks) in helping you understand effective teaching strategies for history education?