Virtual Reality Utilisation in History Education: Discovery Through a Systematic Quantitative Literature Review

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Abstract

This systematic quantitative literature review (SQLR) spans from 2013 to 2023 and includes 40 research articles that meet the inclusion criteria. It explores the intersection of virtual reality (VR) and history education. This SQLR serves as a scoping of the field, discovering key contributors, publication trends, research types, geographic distribution, participant demographics, educational levels, research methods and designs, key findings, and thematic relationships among key concepts. The key findings indicate a surge in VR-related history/social studies research, with Europe leading in contributions, followed by Asia, North America, South America, and both Africa and Oceania sharing fifth place. Students were the main research participants in the studies included in the review, with the majority of the studies being empirical in nature. The majority of studies focused on higher education and were conducted utilising quantitative research methods and experimental research design. The findings reveal that VR significantly enhances historical knowledge and increases interest. However, it was also found that studies tend to focus on students' attitudes towards VR as a technology rather than its impact on learning. This study also provides implications.

Keywords: *Virtual Reality; Historical Knowledge; History Education; Challenges; Opportunities; Systematic Review*

Background

History provides a foundation for humanities and context for understanding societies, ideas, and various aspects of human culture. Over the years, the subject has sought to impart a sense of patriotism, promote ethics and morality, develop communication skills of students, broaden students' understanding of global issues, promote socialisation, and cultivate critical and historical thinking skills (Owusu-Ansah, 2011; Bonsu et al., 2020). History unfolds within communities, driven by activities and societal changes over time (Fordham, 2012). All events that fall within the confines of history are defined in time (period) and space (geography) and are socially significant. This assumes that events, or actions from the past involving inanimate entities or natural elements, fall within the scope of history only when they impact the society studied by the historian (Collingwood, 1946; Adeoti & Adeyeri, 2012).

The nature of history implies that it involves knowledge scrutinised by historians (Fordham, 2012). Nevertheless, the anticipated role of historians in reconstructing the past remains a subject of debate among historians and philosophers of history (Atkinson, 1978; Stanford, 1998). The nature of history presents an avenue to explore four characteristics of historical facts, which are: 1. Historical facts are integrated; 2. are sometimes directly unobservable; 3. have different patterns of grouping and explanation; and 4. could have elements of subjectivity (Oppong & Quan-Baffour, 2014). Historical facts are inherently integrated with the social sciences and humanities (Oppong & Quan-Baffour, 2004). The integrated nature means that history intersects with facts, concepts, and theories in other disciplines, particularly the social sciences and humanities, such as economics, politics, geography and sociology (Oppong & Quan-Baffour, 2014; Smith, 2011). However, Horn and Ritter (1986) observe that a crucial issue of concern lies in how historians select and appropriate ideas, concepts, and methods when reconstructing the past, but not in the concepts or methods borrowed by history from other disciplines.

Further, since historians investigate past events, often predating the historian's time, this sometimes makes the nature of history not directly observable (Oppong & Quan-Baffour, 2014; Collingwood, 1946). The internal and external aspects of the historical facts, which are past and gone (occur and disappear), cannot be directly reproduced for interrogation and investigation, and the motives that lay behind the human actions in the past are not amenable to present scrutiny (Taylor, 2012). Thus, historical sources, which served as a basis for reconstructing the past, are mere representations or traces of historical occurrences, potentially falling short of conveying precise details of events (Oppong & Quan-Baffour, 2014).

Concerning historical grouping and explanation, historical facts are grouped and explained or interpreted in different patterns. Grouping involves

putting related historical activities or events together and assigning causes (Oppong & Quan-Baffour, 2014). Explanation in the context of historical analysis entails providing descriptions and justifications for events. It involves addressing inquiries concerning the "what," which pertains to facts, the "how," which involves interpretation, and the "why," which delves into the causes underlying events (Munslow, 2006). Grouping and explanations of historical facts are carried out using development, colligation, covering law, and uniqueness approaches.

These four modes of historical explanation could potentially lead to elements of subjectivity in history teaching and learning. Subjectivity in history is a bone of contention between positivist and relativist historians and philosophers of history. Subjectivity stems from the problem of grouping, selection, and interpretation of historical facts. While positivist historians argue that history is objective because its methods align with natural sciences, relativists, on the other hand, maintain that history is a product of human creativity, making it difficult to achieve objectivity (Husbands, 2011; Tucker, 2013). The problematic nature of historical facts and lack of consensus among experts regarding the nature of history create confusion for both teachers and students.

Grappling with diverse perspectives, conflicting principles, methodologies, interpretations, and sources, teachers encounter problems in determining the most effective pedagogical approaches. In turn, many teachers find solace in the narrative approach to delivering history instruction making history teaching and learning less engaging, boring and monotonous (Boadu, 2022; Mayer, 2006). Technologies offer some affordances in history education. With the emergence of digital technologies in education, there has been a gradual shift from traditional teaching and learning practices to the use of technology-enabled interactive multi-modal approaches in history education (Malysheva et al., 2022). This shift is driven by the desire to enhance student engagement, provide more interactive learning experiences, and cater to diverse learning styles (Tang, 2023).

Virtual Reality and History Education

However, despite the benefits of these technologies, they often fall short of fully immersing learners in historical past events. While the use of games in history instruction has demonstrated some success in immersing learners in the distant past (Clyde et al., 2012), immersive virtual reality (IVR) has proven even more successful. Unlike traditional videos, IVR allows students to actively engage with historical environments, enhancing their understanding through interactive and spatially immersive experiences. For instance, students can transcend temporal boundaries and journey into the distant past to experience and interact with historical events first-hand—a feat that would have been difficult or impossible through conventional means such as textbooks and lectures. Moreover, transporting students from their school to a historical site, often far away and possibly involving high costs or safety concerns, becomes a seamless

and accessible educational endeavour with the aid of VR technology. VR's multi-sensory stimuli also engage multiple human senses, i.e., auditory, visual, tactile, olfactory, or gustatory stimuli simultaneously, enabling visual realism, evoking a stronger sense of learner presence, and enhancing the overall worthwhile educational experience (Rheingold, 1991). Thus, students could readily and easily learn abstract concepts in history effectively with IVR.

In addition, students can interact and engage with the learning content and collaborate in the virtual world to learn history. This, in turn, enhances students' knowledge, increases interests, positive learning experiences, and attitudes to the subject history (Cabero-Almenara et al., 2022; Gibson et al., 2022; Pajak, 2022; Jiang & Liu, 2023; Mohsen et al., 2023). It is crucial to note that, the continued growth of technology-enhanced history education relies on how the academic community and developers engage with VR design, development, and application to teaching and learning. Considering the growing scholarship on VR-related history education, this systematic quantitative literature review (SQLR) aims to examine contributors, publication trends, research types, geographic distribution, participant demographics, educational levels, research methods, and thematic focus in the existing literature.

This SQLR addresses the following aspects of the publications that meet the eligibility inclusion criteria:

1. The key contributors to VR history education research.
2. The publication trends.
3. The types of publications produced by researchers.
4. The types of research outputs.
5. The region of affiliation of first authors/Geographic distribution of studies.
6. The participants' distribution of studies.
7. The educational levels.
8. Research methods and research designs.
9. The key themes of research.
10. The main theme and its relationship with other themes.

Literature Review

Conceptualising Virtual Reality

Virtual Reality (VR) has been defined differently by earlier scholars. According to Sutherland (1965), VR is the use of computer technology to create the effect of an interactive three-dimensional world in which the objects have a sense of spatial presence. Coates (1992) also posits that VR is an electronic simulation of environments experienced via head-mounted eye goggles and wired clothing enabling the end-user to interact in realistic three-dimensional situations. In a similar vein, Greenbaum (1992), also defines it as “an alternate world filled with computer-generated images that respond to human movements. These simulated environments are usually visited with the aid of an expensive data suit which features stereophonic video goggles and fibre-optic data gloves” (p. 58). Some recent definitions include Lowood (2023) who defines VR “as the use of computer modelling and simulation to enable individuals to engage with an artificial three-dimensional (3-D) visual or other sensory setting (para, 1),” and Fuchs et al. (2011), “VR is a scientific and technical domain that uses computer science and behavioural interfaces to simulate in a virtual world the behaviour of 3D entities, which interact in real-time with each other and with one or more users in pseudo-natural immersion via sensorimotor channels”(p.8). Overall, these definitions share commonalities: they emphasise the use of computer technologies, interactive 3D environments, and immersive experiences as key components of VR.

VR systems can be categorised into either three degrees of freedom (3DOF) or six degrees of freedom (6DOF) (Rheingold, 1991; Gregory et al., 2013). The 6DOF configuration offers enhanced immersion compared to 3DOF by enabling tracking and replication of movement in six different directions within a 3D environment (Gregory et al., 2013). Specifically, 3DOF systems track rotational movements around the three axes: pitch, which is up-down, yaw, which is left-right, and roll, which is rotation. In contrast, 6DOF systems go beyond by tracking both rotational movements (pitch, yaw, and roll) and translational movements (forward/backward, up/down, left/right). This distinction is pivotal in understanding the varying levels of immersion and interactivity provided by these VR configurations. There have been modern advances in VR to include laser and holographic projection into the eye, optical scanners to capture 3D of a physical environment, vests, hand tracking, haptic feedback systems, and spatial audio technologies, among others (Anthes et al., 2016). This development is known as the “third wave" of VR (Heim, 2017). The third wave encompasses a broader range of advancements contributing to more immersive and realistic virtual experiences, including the engagement of all the five senses, although the sense of taste remains largely underexplored.

Types of VR

VR encompasses various levels of immersion, which are categorised broadly into fully immersive, semi-immersive, and non-immersive experiences (Bohil, 2009; Lorusso et al., 2020). Each type offers distinct levels of user engagement and interaction with virtual environments.

1. **Non-immersive**: In a non-immersive VR, the fundamental configuration involves displaying a 3D world within a window of a computer screen. These systems demand less computing capabilities such as high-performance graphics and Random Access Memory (RAM). Interaction and navigation within the virtual environment are through keyboard commands, mouse input, or gaming controllers. Such systems include computer games such as Minecraft or The Sims, where the user views the virtual world on a standard screen and interacts with it using a mouse, keyboard, or controller.

2. **Semi-immersive VR:** Semi-immersive VR offers users a partially virtual environment, providing the perception of being in an alternate reality, often a 3D environment while maintaining a connection to the physical surroundings. Semi-immersive VR utilises high-resolution displays, powerful computers, and projectors or sophisticated simulators that emulate aspects of real-world mechanisms in design and functionality. A typical example is a flight simulator.

3. **Fully immersive VR**: Immersive VR systems place the user within a virtual environment, creating a compelling experience by engaging the senses of the user with computer-controlled stimuli. Immersive involves a Head-mounted display (HMD) and rear-projection screen with a stereo-capable display. Additional tracking devices are frequently incorporated to capture hand and body motion. They may also provide spatial audio and haptic feedback, enriching the immersive experience. HMD systems include the Oculus Quest and HTC Vive.

Materials and Method

A systematic quantitative literature review (SQLR) is a methodological and comprehensive review of existing studies on a topic or research problem that follows clearly defined inclusion and exclusion criteria. The main aim of SQLR is to offer an overview of a current state of knowledge in a particular field or research problem by systematically identifying, evaluating, and synthesising all pertinent research evidence (Snyder, 2019). The researchers embraced the SQLR outlined by Pickering and Bryne (2014) and Pickering, Grignon, Steven, Guitart and Byrne (2015). This methodology offers a reproducible approach, presenting a step-by-step method for comprehensively reviewing the literature. This study began with a search strategy using the keywords “Virtual Reality in History Education OR Teaching” and “Virtual Reality in Social Studies Education OR Teaching.” The above keywords were developed into lens.org’s search syntax, thus “title: (virtual AND (reality OR world)) AND (educat* OR school OR teach) AND (histor* OR social)” to retrieve relevant articles that fit into the scope of the study. Lens.Org is a freely accessible database that offers entry to a vast repository of more than 200 million scholarly records. These records are drawn from diverse sources like Microsoft Academic, PubMed, Crossref, OpenAlex, and UnPaywall, among others.

To enhance the reliability and accuracy of the SQLR, an independent reviewer monitored the selection and inclusion process to ensure consistency and accuracy in the materials included in the final review. The reviewer applied predefined inclusion criteria to evaluate each study's relevance and quality. Additionally, the reviewer cross-referenced the selected studies with the initial search results to ensure comprehensive coverage and identify any potentially missed articles. Any discrepancies or uncertainties in the selection process were resolved through consensus with the reviewer and the primary researcher. The review process was conducted with Covidence.org software. This added an extra layer of scrutiny, reinforcing the credibility of the review process and reducing inclusion and exclusion bias. The final data after the review were manually extracted into an Excel spreadsheet and then analysed quantitatively, while the Leximancer software was used to develop a concept map depicting the relationship among major concepts in the published articles. The entire process is visually represented in Figure 1.

Inclusion criteria:

1. Empirical research-based and/or technical development papers.
2. Articles published in the past ten years, from January 2013 to November 2023.
3. Articles published in the English language.
4. Articles focusing on VR use for History or Social Studies.
5. Publications that are peer-reviewed journal articles, book chapters, and published conference proceedings with full-text access.

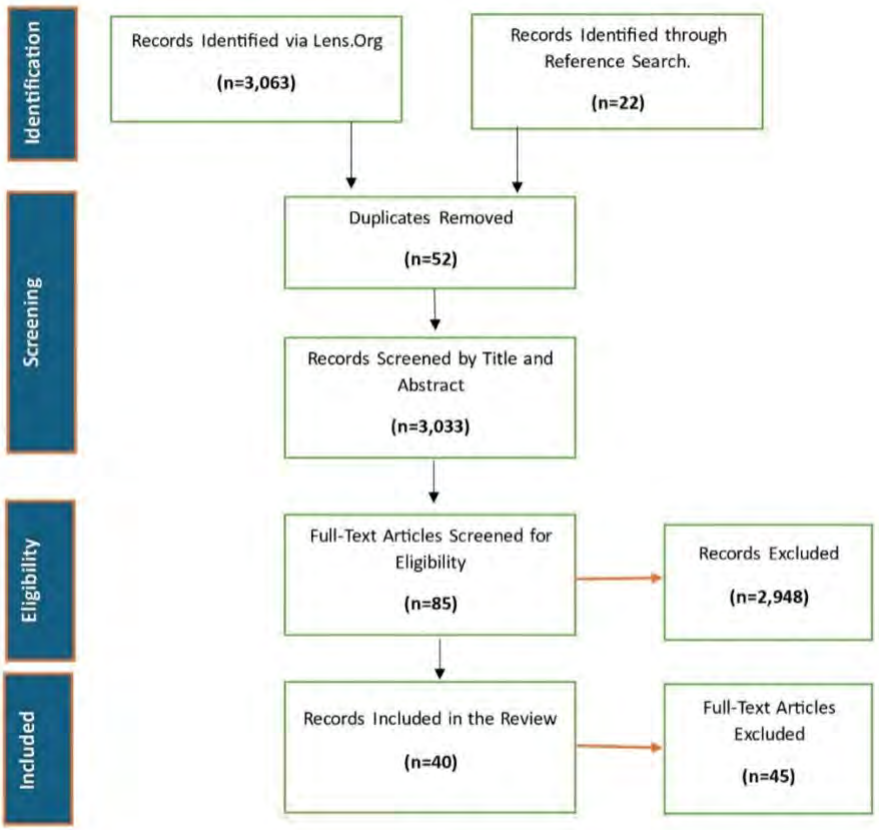
Exclusion Criteria:

1. Publications in a non-English language.
2. Publications that are not within 2013 to November 2023.
3. Publications with non-history and social studies-related focus.
4. Non-peer-reviewed Publications.
5. Publications that are either literature reviews or systematic reviews.

A summary of the process is represented in Figure 1.

Figure 1

The Review Process



Findings and Discussion

This section presents findings and discussions of the SQLR. This is organised into contributors, publication trends, research methods, research designs, publication types, types of research output, country of affiliation by main authors, nature of participants distribution of studies, educational level, educational level and theme VR and its relationship with other themes.

Contributors

The 40 articles that met the inclusion criteria for this vSQLR were authored by a total of 40 different authors, encompassing both single-author works and collaborations. Collaborations were not treated as distinct contributions for each author in this analysis. Instead, the main contributor or first author was counted. It is revealed that 6 publications had single authors,10 had two authors and the majority of the publications representing 24 had more than two authors. Hutson was the only author who published two. Table 1 presents data on the authors of the 40 studies included in the systematic review.

Table 1
Key Contributors

S/N	Author	Publication Year	Type of Publication	Country of Affiliation of First Author	Continent	Type of Research	Participants	Research Method	Research Design	Study Level
1	Malik et al.	2020	Refereed Journal Article	Italy	Europe	Empirical	Students and Professionals	Mixed Method	Survey and Interview	Not Available
2	Guimaraes et al.	2022	Conference Paper	Brazil	South America	Non-Empirical	Not Available	Not Available	Technical Development	Not Available
3	Hutson & Fulcher	2022	Refereed Journal Article	USA	North America	Empirical	Students	Mixed Method	Design-Based Research	University
4	Cheng et al.	2022	Conference Paper	Malaysia	Asia	Empirical	Students	Qualitative	Focus-Group	University
5	Blancas et al.	2021	Refereed Journal Article	Spain	Europe	Empirical	Students and Soldiers	Quantitative	Experiment	High School and College

6	Yildirim et al.	2018	Refereed Journal Article	Turkey	Europe	Empirical	Students	Qualitative	Case Study and Interview	University
7	Huaman	2019	Conference Paper	Peru	South America	Empirical	Students	Quantitative	Survey	University
8	Chan et al.	2021	Refereed Journal Article	USA	North America	Empirical	Students	Quantitative	Survey	University
9	Lacko	2019	Refereed Journal Article	Greece	Europe	Empirical	Students	Quantitative	Experiment	High School
10	Coruh & Karakus	2016	Conference Paper	Turkey	Europe	Non-Empirical	Not Available	Not Available	Technical Development	Not Available
11	Tarng et al.	2023	Refereed Journal Article	Taiwan	Asia	Empirical	Students	Quantitative	Quasi-Experiment	University
12	Toktamysov et al	2022	Refereed Journal Article	Russia	Europe	Empirical	Students	Quantitative	Experiment	High School

13	Fang & Chen	2019	Refereed Journal Article	Singapore	Asia	Empirical	Students	Mixed Method	Design-Based Research	University
14	Nachtigall et al.	2022	Refereed Journal Article	Germany	Europe	Empirical	Students	Quantitative	True Experiment	High School
15	Mohsen	2023	Refereed Journal Article	Lebanon	Middle East	Non-Empirical	Not Available	Not Available	Technical Development	Primary
16	Lewis & Taylor-Poleskey	2021	Refereed Journal Article	USA	North America	Non-Empirical	Students	Not Available	Technical Development	University
17	Remolar et al.	2021	Refereed Journal Article	Spain	Europe	Empirical	Students	Quantitative	Experiment	High School
18	Chrysanthakopoulo et al.	2021	Refereed Journal Article	Greece	Europe	Empirical	Users	Quantitative	Design-Based Research	Not Available
19	Ibrahim & Al-Rababah	2021	Refereed Journal Article	Jordan	Middle East	Empirical	Students	Quantitative	True Experiment	University

20	Moseikina et al.	2022	Refereed Journal Article	Russia	Europe	Empirical	Students	Quantitative	Experiment	University
21	Ijaz	2017	Refereed Journal Article	Australia	Oceania	Empirical	Students	Quantitative	Experiment	University
22	Khakim et al.	2023	Conference Paper	Indonesia	Asia	Empirical	Students	Quantitative	Experiment	University
23	Imran	2023	Conference Paper	Pakistan	Asia	Non-Empirical	Not Available	Not Available	Technical Development	Not Available
24	Li & Li	2022	Refereed Journal Article	China	Asia	Empirical	Students	Quantitative	Quasi-Experiment	Not Available
25	Taranilla et al.	2019	Refereed Journal Article	Spain	Europe	Empirical	Students	Quantitative	Quasi-Experiment	Primary
26	Wong et al	2019	Conference Paper	China	Asia	Empirical	Students and Teachers	Quantitative	Design-Based Research	Not Available

27	Wu et al.	2020	Conference Paper	Taiwan	Asia	Empirical	Students	Quantitative	Quasi-Experiment	University
28	Addo et al.	2023	Refereed Journal Article	Ghana	Africa	Empirical	Students and Teachers	Quantitative	Descriptive Survey	University
29	Fadzil et al	2022	Conference Paper	Malaysia	Asia	Non-Empirical	Students	Not Available	Technical Development	Not Available
30	Cabero-Almenara et al.	2022	Refereed Journal Article	Spain	Europe	Empirical	Students	Quantitative	Quasi-Experiment	University
31	Hutson & Olsen	2022	Refereed Journal Article	USA	North America	Empirical	Students	Mixed Method	Quasi-Experiment	University
32	Maulana & Khansa	2019	Conference Paper	Indonesia	Asia	Non-Empirical	Not Available	Not Available	Technical Development	Not Available

33	Sulistiono et al	2021	Conference Paper	Indonesia	Asia	Non-Empirical	Not Available	Not Available	Technical Development	Not Available
34	Razuvalovaa & Nizamutdinova	2015	Conference Paper	Russia	Europe	Non-Empirical	Not Available	Not Available	Technical Development	Not Available
35	Neves & Pombo	2021	Book Chapter	Brazil	South America	Non-Empirical	Students	Not Available	Technical Development	University
36	Chan et al.,	2022	Refereed Journal Article	USA	North America	Empirical	Students	Quantitative	Experiment	Not Available
37	Parong & Mayer	2021	Refereed Journal Article	USA	North America	Empirical	Students	Quantitative	True Experiment	University
38	Gaitatzes et al.	2022	Conference Paper	Greece	Europe	Non-Empirical	Users	Not Available	Technical Development	Not Available

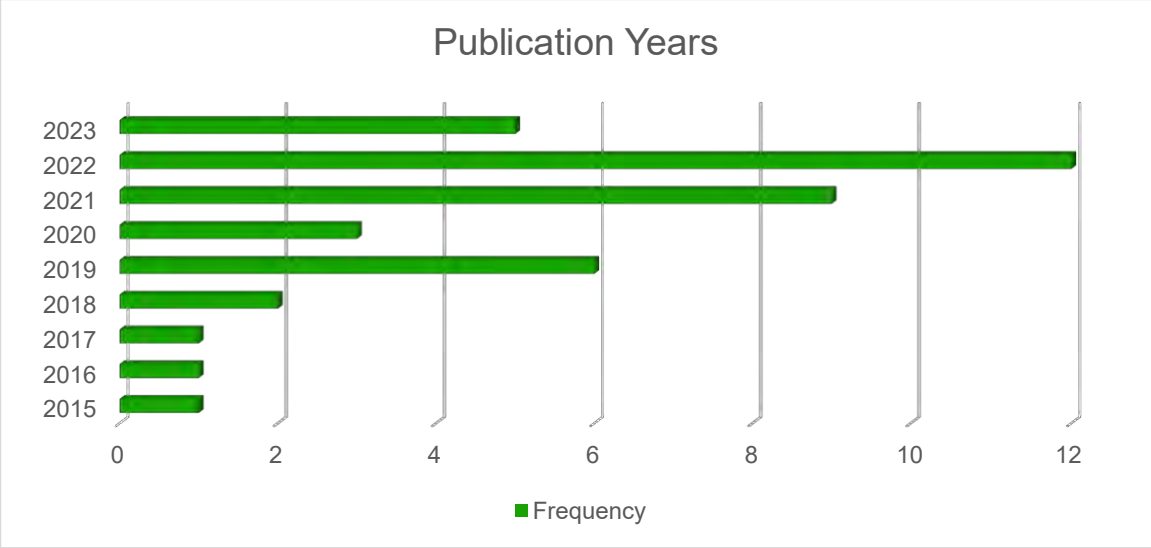
39	Cecotti et al.	2020	Conference Paper	USA	North America	Empirical	Users	Quantitative	Quasi-Experiment	Not Available
40	Kazanidis	2018	Conference Paper	Greece	Europe	Empirical	Students	Mixed Method	Survey and Focus Group	Primary

Publication Trends

Figure 2 presents the results of the publication trends from 2013 to 2023. It is evident that the number of published articles has significantly increased over the period examined. There is a notable rise from 2018 onwards, with a substantial increase in 2021 and 2022. It is anticipated that 2023 will have additional publications since some articles will be published in late 2023 (which were not captured in the review) or be added to academic databases in early 2024. The surge in publications from 2018 onwards indicates increased research activity or heightened interest in the field during these later years. Additionally, the upward trend could be attributed to the commercialisation of VR with Meta's acquisition of Oculus and the emergence of other VR players in the industry such as Samsung, HTC Vive, Google and Microsoft, among others, thereby making VR technology more accessible, quality and affordable than ever before.

Figure 2

Publication Trends



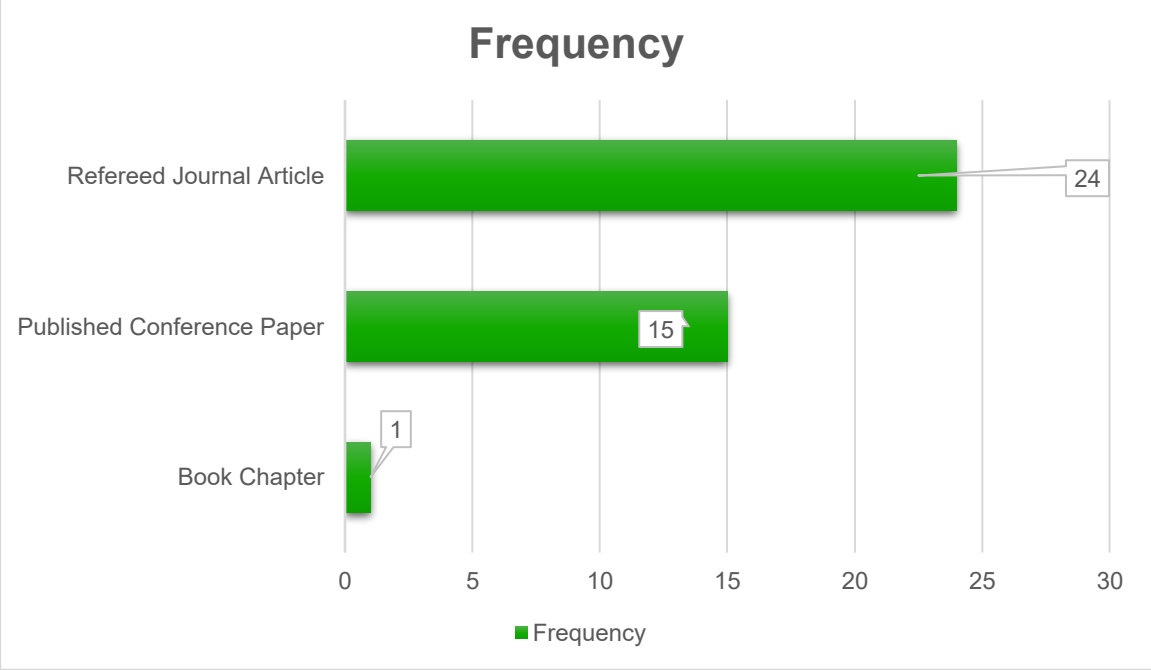
Types of Publications

Of the 40 publications included in the review, the majority were refereed journal articles, followed by published conference papers, with a smaller representation of book chapters. This indicates the preference among researchers to disseminate their research in peer-reviewed rather than in conferences and book chapters. The underrepresentation of book chapters is not particularly surprising due to the number of book chapters being paper-based and, therefore, less accessible in academic databases used for the review. Additionally, book chapters seem to take a longer time

from the planning phase to final publication compared to conference publications, impacting the smaller representation of book chapters in the review. This is presented in Figure 3.

Figure 3

Types of Publications



Types of Research Outputs

The results from Table 2 show that the majority of studies were empirical research (72.5%), while the minority(27.5%) were non-empirical, focusing on technical development. Empirical research involves collecting and analysing data (quantitative, qualitative or mixed) to address specific research questions or test hypotheses (Gaskell, 2000; Dan, 2017). Non-Empirical research, conversely, does not involve data collection and analysis (Dan, 2017). All the 11 studies categorised under non-empirical were technical development research focused on the design, development and or testing of VR educational resources. These papers emphasised the description of the design and development cycle of VR educational software without experimentation and evaluation of the software by empirically collecting quantitative or qualitative data for analysis.

The outcome implies that researchers emphasise empirical research even when developing and evaluating VR intervention in history education by collecting empirical data for qualitative and quantitative analysis instead of just the development and description of VR resources. Technical development-type research does not measure

the effectiveness of VR intervention, nor does it assess students' attitudes, perspectives, experiences, and interests, among other factors.

Table 2

Types of Research Outputs

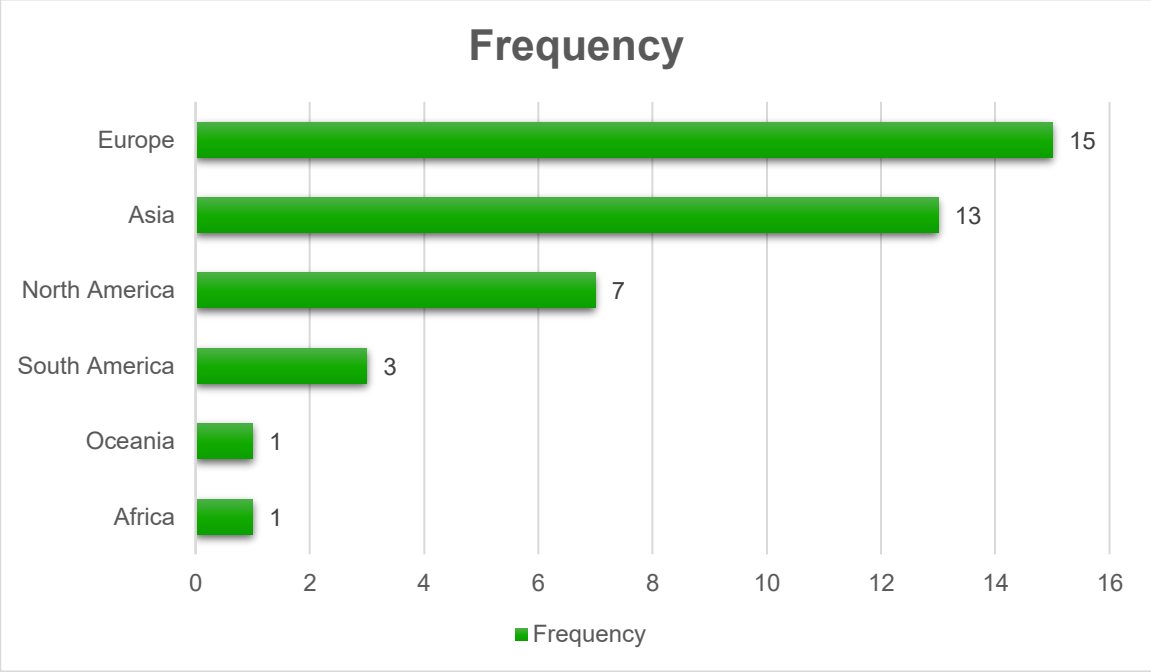
Type	N	Percentage (%)
Empirical	29	72.5%
Non-empirical (Technical development)	11	27.5%
Total	40	100%

Region of Affiliation of Main Authors

Figure 4 reports on the region of affiliation of main authors. Of the 40 papers, Europe (including Turkey and Russia) produced the highest number, with 15 studies, followed by Asia (including the Middle East) with 13 studies. North America and South America produced 7 and 3 studies, respectively. Africa and Oceania produced the least publications, with 1 each. The dominance of Europe, Asia and North America could be attributed to the robust and active involvement of their institutions and researchers in exploring VR applications in history education. Mention could also be made of the availability of research funding and a sophisticated infrastructure supporting VR-related studies, which are lacking in Africa and some less developed countries in Oceania (ICT Capacity Building, 2005; Boadu et al., 2012; Bonsu et al., 2020; Shah, 2023). Africa and Oceania could mitigate these challenges by collaborating with researchers from Europe, Asia and North America. Moreover, addressing these challenges becomes imperative to foster more equitable global participation of Africa and Oceania in VR in history education research.

Figure 4

Region of Affiliation of Main Authors



Nature of Participants Distribution of Studies

The participant data, presented in Table 3, provide insights into the demographics of the studies included in the review. The majority of the studies involved students, comprising 65%, indicating a predominant focus on VR in history education from students' perspective. Users accounted for 7.5%, while a combination of students and teachers, as well as students and others, each represented 5%, respectively. The "Not Available" category, representing studies where participant details were not specified, constituted 15% of the total.

Using students as participants was mostly appropriate for studies measuring effectiveness, students' interests, attitudes, perceptions and engagement of VR. However, teachers are pivotal in shaping the academic success of students. Hattie (2003) contends that instead of asking "what matters" in isolation, the suggestion is to investigate and understand where the major sources of variance in students' achievement lie. He concludes that "it is what teachers know, do, and care about which is very powerful in this learning equation" (Hattie, 2003, p.3). Research also suggests that since teachers are final curriculum implementers, it is essential for studies to include their opinions, challenges and self-efficacy, among others, instead of solely focusing on students (Bonsu et al., 2020). The finding also reveals an overwhelming trend of exclusion of participants, as evidenced by the "Not Available" category . This, in

turn, either hinders the evaluation of such VR interventions or makes it difficult to assess which demographic these interventions are most effective for.

Table 3

Nature of Participants Distribution

Participant	N	Percentage (%)
Students	26	65%
Users	3	7.5%
Students and Teachers	2	5%
Students and others	2	5%
Not Available	7	15%
Total	40	100%

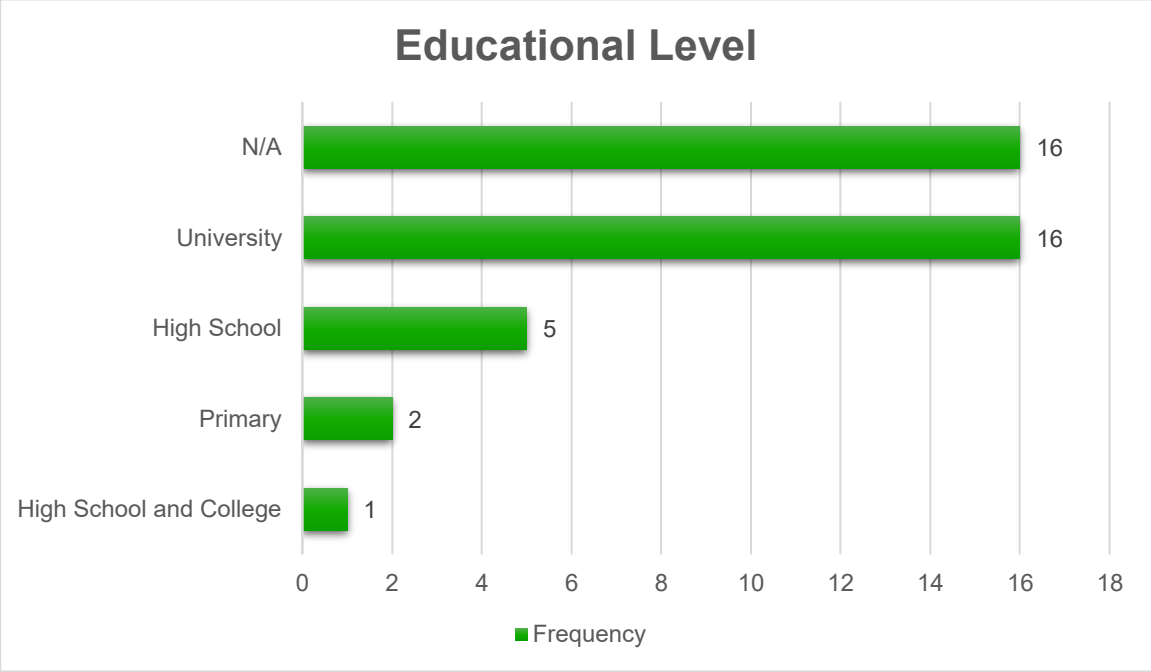
Educational Levels

From Figure 5, the 40 research outputs incorporated in the study reveal a diverse distribution across all educational levels, with a notable emphasis on universities/higher education (N=16), indicating a stronger focus on higher education, while the inclusion of high schools (N=5) underscores attention to VR applications in history education. This indicates that a majority of research focuses on university and high school students as study participants. Few studies utilised primary school students (N=2) and the combination of senior high school and university students (N=1).

Fifty per cent of the body of literature (N=16) excluded the participants' educational level in their study. These studies did not specify the educational level of their targeted participants. Out of these studies (N=16), 8 of them were non-empirical studies focusing on the design, development and/or testing of VR resource/intervention in history education, while the remaining 8 were empirical research that excluded the level of education of their research participants. The over-concentration of studies at the higher education can be attributed to the resource availability in universities and the established research opportunities . In contrast, concerns about developmental appropriateness, ethical considerations, and practical challenges could influence the limited exploration in pre-tertiary education, particularly at the primary school level that focuses on students in grades 1 to 6.

Figure 5

Educational Levels



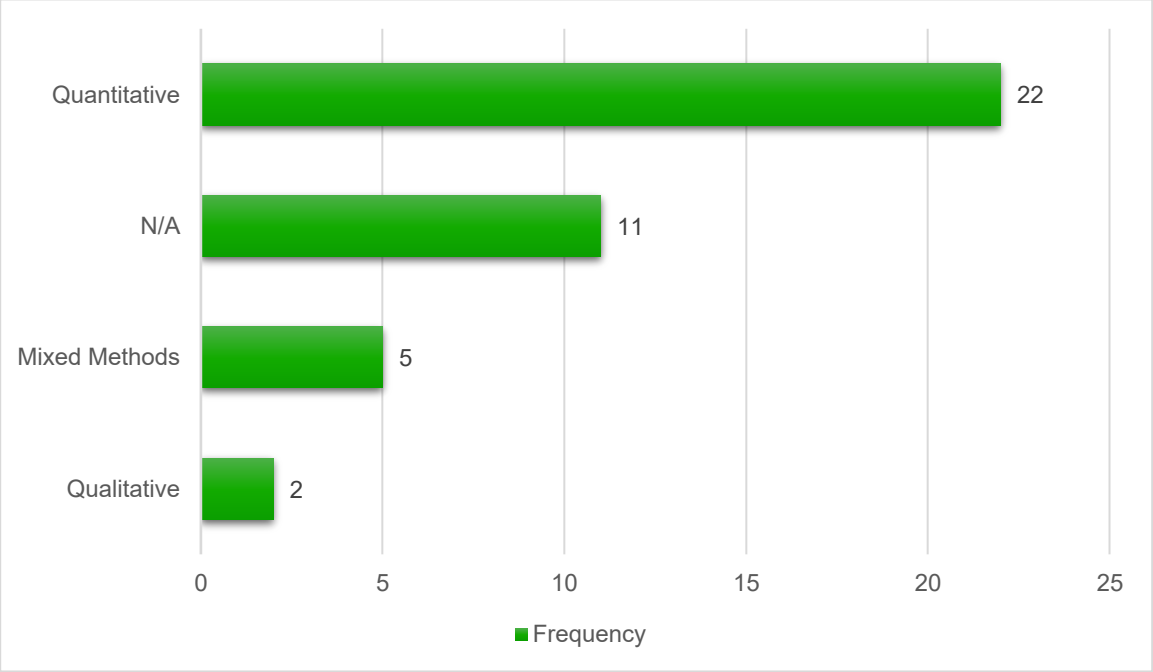
Research Methods

The result reveals that, among the 40 studies, 22 adopted quantitative methods, 2 utilised qualitative methods, and 5 employed mixed methods. The quantitative approach is well-suited for evaluating the effectiveness of VR interventions, as it focuses on empirical data collection for statistical analysis. This allows for descriptive, inferential and correlational analysis (Bryman & Bell, 2007; Creswell & Poth, 2017). Qualitative methods, in contrast, emphasise a qualitative exploration of a subject matter (Creswell, 2013; Creswell & Poth, 2017a). Mixed methods, on the other hand, integrate both quantitative and qualitative research. This approach provides a more comprehensive understanding of the subject matter by allowing researchers to triangulate findings and provide a richer context for interpreting quantitative results (Creswell & Creswell, 2017). Therefore, studies employing these methods are becoming more prevalent in VR history research.

Notably, 11 studies (27.5%) were dedicated to technical development research. This accounted for the second majority of research methods after quantitative methods. This highlights the growing advancement of the technological aspects of VR in history education around the world. These categories of studies delve into the development cycle of VR tailored for historical education, museums and historical sites. This is represented in Figure 6.

Figure 6

Research Methods



Research Designs

Examining the distribution of research designs in Table 4, it is evident that technical development research was the most frequently employed, constituting 11 studies (27.5%). This was followed by experimental research designs, with 8 studies (20%). In Addition, quasi-experimental research designs were employed in 7 studies each (17.5%), while design-based research was utilised in 4 studies, representing 10%. Moreover, descriptive surveys and true experiments were utilised in 3 studies (7.5%), respectively Lastly, 4 studies (10%) fell into the "other" category, suggesting diverse and potentially unconventional research designs not captured by the specified categories. These studies did not explicitly specify their research designs except for the research instruments used for data collection. They mainly utilised either a combination of survey and interview, survey and focus group, or only focus-group.

The surge in the experimental research designs may indicate the preference of researchers to manipulate an independent variable—such as a VR intervention— to observe the effect on a dependent variable, often related to students' learning outcomes, motivation, interests, and engagement, while controlling for other variables. However, none of the 8 experimental studies described their random assignment procedure. Consequently, the researchers casually used the term “experiment” without providing any details regarding random assignment to the control and treatment groups. This omission makes it impossible to determine whether these studies were true randomised experiments or quasi-experimental designs. It is noteworthy that quasi-experimental designs are more prevalent in educational technology research than true

experimental designs (Gopalan et al., 2020). This may be due to their practicality and feasibility to implement in real-world educational settings. Unlike true experimental designs, they allow interventions to be implemented in existing educational settings without disrupting the normal flow of academic activities.

Experiments (True and quasi-experimental designs) were preferred since they are less time-consuming than design-based research (DBR). This could explain why design-based research was less frequently used, amidst calls for its incorporation in educational technology (Amiel & Reeves, 2008; Štemberger & Cencič, 2016). However, it is important to note that DBR is merely a research design but primarily a methodology. It provides a structured approach for researchers to collaboratively develop and refine educational innovations within authentic learning environments. This methodological flexibility allows DBR to be integrated with various research designs, accommodating diverse research contexts and objectives while aiming for practical educational improvements (Campanella & Penuel, 2021). The 4 studies captured under design-based research did not meet some of the principles of design-based research such as iterative cycles of design, implementation, and evaluation. However, these studies focused more on the design and development of a new educational tool (VR experience) and the subsequent evaluation of its impact on students' learning experiences.

Table 4

Research Design

Research Design	N	Percentage
Technical development	11	27.5%
Experiment	8	20%
Quasi-experiment Designs	7	17.5%
Design-based research	4	10%
Descriptive survey	3	7.5%
True Experimental Designs	3	7.5%
Other	4	10%
Total	40	100%

The Main Theme and Its Relationship with other Themes

The findings, as illustrated in Table 5 indicate that the majority of studies (35.41%) focused on the effectiveness of virtual reality in enhancing learning outcomes. In contrast, a minority viewpoint (2.08%) suggests that VR might be ineffective in knowledge transfer compared with traditional video lessons. While learner's preference for immersive 3D or traditional video plays a crucial role in determining the effectiveness of VR and traditional video lessons in knowledge transfer, this finding highlights the

need for further investigation into the effectiveness of VR as an educational tool in history education, taking into account students' diverse learning preferences and experiences. Moreover, 10.41% of studies reported VR increasing history learner interests, while 6.25% of studies revealed that VR promotes positive student attitudes.

However, one study each, comprising 2.08%, focused on students' motivation, educational experiences, virtual trips, perceptions, VR usability, self-efficacy, acceptance of VR in history education, and the immersive nature of VR in history teaching. These studies reported positive results indicating that VR utilisation increases students' motivation to learn, enhances their educational experiences, improves their self-efficacy in history, and helps them embark on field trips virtually. The results also revealed that history students generally accept the use of VR for history instruction, with one study modelling students' acceptance of VR using the Technology Acceptance Model. 11 studies (22.91%) focused on the design and development of VR instruction . Although these studies did not gather empirical data to evaluate the effectiveness of the instructional apps concluded that their apps can enhance learning, students' interest, and engagement.

The results of this SQLR confirm that VR is an effective tool for fostering history students' knowledge and understanding. This was evident in 17 studies, which shows that VR improves learning outcomes, memory, cognition, and metacognition (e.g. see Blancas et al., 2021; Chan et al., 2021; Lacko, 2019; Toktamysov et al., 2022; Nachtigall et al., 2022). However, the majority of reviewed studies primarily focus on substantive knowledge, such as students' recall and understanding of first-order concepts like dates, names of people, and places, which are vital in students' progression in history, as they serve as the foundation for understanding procedural knowledge (Bertram, 2009). These studies often prioritise these aspects over historical thinking, involving the cognitive skills and processes necessary for the analysis and interpretation of historical evidence (Baron, 2012; Parkes & Donnelly, 2014; VanSledright, 2004). Thus, while substantive knowledge forms a critical basis in historical knowledge, historical thinking extends beyond mere memorisation and reproduction of facts. It enables students to grasp the broader significance of historical events, understand different perspectives, and discern the complexities of cause and effect in historical narratives (Wineburg, 2010). Incorporating historical thinking skills in history education through VR could enrich learning experiences by promoting critical analysis, interpretation of sources, and a deeper engagement with historical contexts. Notwithstanding, these findings resonate with existing literature, which posits that VR's multi-sensory nature engages auditory, visual, tactile, olfactory, and gustatory stimuli, enabling visual realism, evoking a stronger sense of learner presence, and enhancing learning outcomes (Gregory et al., 2013).

Furthermore, it was also revealed that VR increases learner's interests in history education (Guimaraes et al., 2022; Yildirim et al., 2018; Chrysanthakopoulo et al., 2021; Wong et al., 2019; Maulana & Khansa, 2019). Over the years, students' interest in history has declined due to an over-reliance on narrative and text-based teaching

approaches, which often leads to student emotional disengagement (Oppong & Quan-Baffour, 2004; Remolar et al., 2021; Davies & Ryan, 2008; Dwarko, 2007; Nuttall & Wright, 2000). By using VR in history lessons, instructors can rekindle students' interests in the subject by making history lessons exciting (Cheng et al., 2022) and engaging (Hutson & Olsen, 2022). Moreover, of the four studies examining attitudes, three focused on students' attitudes towards VR technology (Kazanidis, 2018; Wu et al., 2020; Cabero-Almenara et al., 2022), while only one study (Wu et al., 2020) examined students' attitudes towards history through VR technology as a medium of instruction.

Despite history students' acceptance and usability of VR in history education (see Cabero-Almenara et al., 2022; Cecotti, et al., 2020), Chan et al. (2022) and Taranilla et al. (2019) identified that its use is marred by technological and system challenges such as internet challenges, software, usability issues, and hardware updates. These challenges, if addressed, could unleash the potential of VR in history instruction.

Table 5

Main Themes

Main Themes	N	Percentage
Enhances learning outcomes	17	35.41%
Increases learners' interest	5	10.41%
Promotes positive attitudes	3	6.25%
VR use in history education is associated with challenges	2	4.16%
Is ineffective in knowledge transfer compared with Video Lessons	1	2.08%
Improves educational experiences	1	2.08%
Increases students' motivation	1	2.08%
Usability of VR history resources	1	2.08%
Technology acceptance model	1	2.08%
Enhances easy virtual trips	1	2.08%
Positive Perceptions	1	2.08%
Virtual reality enhances learning satisfaction	1	2.08%
Enhances students' self-confidence (Efficacy)	1	2.08%
VR is socially immersive	1	2.08%
N/A	11	22.91%
Total	48	100%

Theme VR and its relationship with other themes

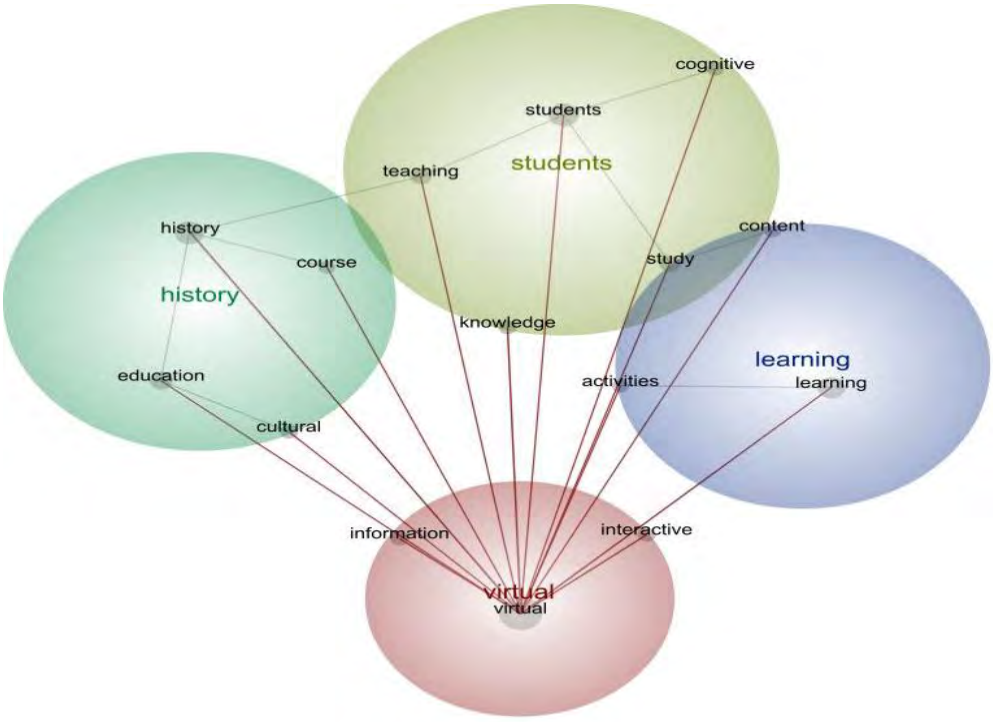
Virtual Reality (VR), which encompasses 3D and virtual world technologies, emerged as the central theme in the Leximancer analysis, as shown in Figure 7. This theme appeared in the published research outputs in close relationship with concepts such as information and interaction. VR also intersects significantly with other thematic areas, including History (incorporating historical, heritage, cultural, and archaeological

perspectives), Students (encompassing users and participants), and Learning. Additionally, the integration of VR in history education is depicted as a mediated process in the analysis. VR facilitates a dynamic interaction between learning and historical content. This interaction is not only influenced by the technological aspects of VR but also by the roles of students and teaching processes within educational settings.

The Leximancer analysis demonstrates VR's pivotal role in enhancing learning experiences in history education. By leveraging VR, educators can immerse students in historical contexts, providing them with interactive and engaging learning environments. This approach not only enriches students' understanding of historical events but also enhances their historical thinking skills and emotional connection to historical events.

Figure 7

Theme VR and its relationship with other themes



Summary and Implications

This SQLR , which extends across the decade from 2013 to 2023, provides a comprehensive overview of key contributors, publication trends, research types, geographic distribution, participant demographics, educational levels, research methods, main themes , and thematic relationships among key concepts. The SQLR reveals a notable surge in the rate of VR-related history research, primarily in Europe, Asia and North America. Additionally, it was found that students are the primary focus as research subjects, with a major focus on higher education level, and the majority of studies employ empirical research as opposed to non-empirical research .

The findings also confirm that VR can enhance students' learning outcomes, interests, and promote positive attitudes. It was also revealed that the majority of studies focus on students' attitudes towards VR as a technology rather than its impact on learning. However, there is a dearth of research dealing with history teachers' perspectives of VR and the impact of VR on pre-tertiary education. Moreover, the study identifies an emphasis on empirical studies, which indicate the importance of collecting and analysing data for a comprehensive understanding of VR's impact on student engagement in the history educational context.

The study also sheds light on the challenges, mainly technological issues, associated with VR in history education and calls for addressing these challenges to unleash the full potential of VR in enhancing historical inquiry. The results emphasise the need for more equitable global participation in VR-related history research, encouraging regional collaboration. The Leximancer themes analysis reveals the central role of VR in fostering learning, closely associated with concepts of information, interactivity, history, students, and learning.

The implications of the findings of this study can be summarised as follows:

1. We recommend future studies be conducted to explore teachers' perspectives on the use of VR in history education.
2. Given that studies largely focus on students' attitudes toward VR technology, we recommend that future studies should examine whether VR technologies improve students' emotional engagement in history.
3. Given the dominant focus on higher education, we recommend future research to include primary and high school participants. This will help gauge the impact of VR on younger students and can contribute to a more comprehensive understanding of its effectiveness across different educational levels.
4. Although the studies hint at the technological challenges associated with VR in history education, researchers should consider conducting more in-depth research on these challenges, exploring issues such as emotional, cultural and technological barriers and how these issues/barriers can be mitigated.
5. While the study highlights positive findings related to VR's impact on learning experiences, we recommend longitudinal studies to explore the long-term effects

of VR interventions, especially on students' historical thinking skills. Understanding sustained benefits over time can provide valuable information for educators and policymakers.

6. We recommend collaboration between researchers from different continents to foster a more globally inclusive approach to VR-related history research. This can lead to a more diverse range of perspectives and findings, enriching the overall understanding of the impact of VR in history education.
7. We recommend research into the potential policy implications of integrating VR into history education at all levels of education. Understanding the broader institutional and policy landscape can provide guidance on how to effectively incorporate VR technology into history education.

Author Contribution

N.O.B: Conceptualisation, Data Curator, Formal Analysis, Discussion, Investigation, Methodology, Resources, Software, Validation, Writing: Original Draft, Writing: Review and Editing; J.Z: Conceptualisation, Supervision; D.P: Supervision; G.B: Supervision.

References

Addo, C., Mensah, R., Kpodo, B., & Kumi, J.-N. (2023). The role of field trips in teacher education for teaching social studies in a developing country. *Mediterranean Journal of Social Sciences*, *14*, 23–35. https://doi.org/10.36941/mjss-2023-0034

Adeoti, E. O., & Adeyeri, J. O. (2012). History, the historian and his work: Issues, challenges and prospects. *International Journal of Educational Research and Technology, 3*(4), 36-41.

Amiel, T., & Reeves, T. (2008). Design-based research and educational technology: Rethinking technology and the research agenda. *Educational Technology & Society*, *11*, 29–40.

Anthes, C., García-Hernández, R. J., Wiedemann, M., & Kranzlmüller, D. (2016). State of the art of virtual reality technology. *2016 IEEE Aerospace Conference*, 1–19. https://doi.org/10.1109/AERO.2016.7500674

Baron, C. (2012). Understanding historical thinking at historic sites. *Journal of Educational Psychology*, *104*(3), 833-843.

Bertram, C. (2009). Procedural and substantive knowledge: Some implications of an outcomes-based history curriculum in South Africa. *Southern African Review of Education with Education with Production*, *15*(1), 45-62.

Blancas, M., Wierenga, S., Ribbens, K., Rieffe, C., Knoch, H., Billib, S., & Verschure, P. (2021). Active learning in digital heritage: Introducing geo-localisation, VR and AR at holocaust historical sites. In *Digital Holocaust Memory, Education and Research* (pp. 145–176). Springer International Publishing.

Boadu, G. (2014). An examination of the use of technology in the teaching of history. A study of selected senior high schools in the Cape Coast Metropolis, Ghana. *International Journal of Learning, Teaching and Educational Research, 8*(1), 187-214 https://www.ijlter.org/index.php/ijlter/article/view/155

Boadu, G. (2021). History and public history in Ghana, *Public History Weekly*. http://dx.doi.org/10.1515/phw-2021-18122

Boadu, G. (2022). Why was inquiry practice not there? Analysis of demand-resource empirics of classroom pedagogy. *Educational Review*, 1-25. https://doi.org/10.1080/00131911.2022.2066631

Boadu, G. Donnelly, D. J., & Sharp, H. (2020). History teachers' pedagogical reasoning and the dynamics of classroom implementation, *History Education Research Journal*, *17*(2), 179-194.

Bohil, C., Owen, C. B., Jeong, E. J., & Alicea, B. (2009). 21st century communication: A reference handbook. In 21st century communication: a reference handbook (1–2, pp. 534–542). SAGE Publications, Inc. https://doi.org/10.4135/9781412964005

Bonsu, N. O., Bervell, B., & Arkorful, V. (2020). Computer-assisted instruction in the teaching and learning of history: A systematic review in Africa. *International Journal of Innovation*, *14*(9).

Bonsu, N. O., Bervell, B., Armah, J. K., Aheto, S. K., & Valentina A. (2021) WhatsApp use in teaching and learning during COVID-19 pandemic period: Investigating the initial attitudes and acceptance of students. *Library Philosophy and Practice* (e-journal), *6362*.

Bryman, A., & Bell, E. (2007). The nature of quantitative research. *International Journal of Social Research Methodology, 10*(3), 199–215.

Cabero-Almenara, J., Llorente-Cejudo, C., & Martinez-Roig, R. (2022). The use of mixed, augmented and virtual reality in history of art teaching: A case study. *Applied System Innovation*, *5*(3), 44–44. https://doi.org/10.3390/asi5030044

Campanella, M., & Penuel, W. R. (2021). Design-based research in educational settings: Motivations, crosscutting features, and considerations for designs. In Z. A. Philippakos, E. Howell, & A. Pellegrino (Eds.), Design-Based Research in Education: Theory and Applications (pp. 3-22). Guilford Publications. www.guilford.com/p/philippakos3]

Carretero, M., & Lee, P. (2014). Learning historical concepts. In R. K. Sawyer (Ed.), *Handbook of Learning Sciences* (2nd Edition). Cambridge University Press.

Cecotti, H., Day-Scott, Z., Huisinga, L., & Gordo-Pelaez, L. (2020). Virtual reality for immersive learning in art history. *2020 6th International Conference of the Immersive Learning Research Network (iLRN)*, 16–23. https://doi.org/10.23919/iLRN47897.2020.9155108

Chan, C.-S., Bogdanovic, J., & Kalivarapu, V. (2021). Applying immersive virtual reality for remote teaching architectural history. *Education and Information Technologies*, *27*(3), 4365–4397. https://doi.org/10.1007/s10639-021-10786-8

Cheng, K., Zaini, A. M., Wong, D. C. de, Chong, H., & Lam, I. W. H. (2022). *A framework of student's learning motivation in virtual reality in the history of animation*. 70–75. https://doi.org/10.1109/ICoICT55009.2022.9914887

Chrysanthakopoulou, A., Kalatzis, K., & Moustakas, K. (2021). Immersive virtual reality experience of historical events using haptics and locomotion simulation. *Applied Sciences*, *11*(24), 11613. https://doi.org/10.3390/app112411613

Clyde, J., Hopkins, H., & Wilkinson, G. (2012). Beyond the "Historical" simulation: Using theories of history to inform scholarly game design. *Loading: The Journal of the Canadian Game Studies Association, 6*(9),3-16.

Coates, G. (1992). Invisible site - A virtual show, a multimedia performance work presented by George Coates Performance Works.

Collingwood, R. G. (1946). *The idea of history*. Oxford: Clarendon Press.

Coruh, L., & Karakus, E. O. (2016). Developing 3D graphics software as educational material for museum education course (The case of hunat social complex). *New Trends and Issues Proceedings on Humanities and Social Sciences*, *2*(1), 657–666. https://doi.org/10.18844/prosoc.v2i1.1006

Creswell, J. W. (2013). Qualitative inquiry and research design: Choosing among five approaches. Sage Publications.

Creswell, J. W., & Creswell, J. D. (2017). Research design: Qualitative, quantitative, and mixed methods Approaches. Sage Publications.

Creswell, J. W., & Poth, C. N. (2017a). Qualitative inquiry and research design: Choosing among five approaches. *Health Promotion Practice, 18*(2), 208–215

Dan, V. (2017). Empirical and non-empirical methods. In International Encyclopaedia of Communication Research Methods (pp. 1-3). Hoboken, NJ: Wiley.

Fadzil, N. A. S. N. M., Lah, H. A., & Mustafa, W. A. (2020). The usage of virtual reality technology through histopology application to increase orang asli imagination skill in history. *Journal of Physics: Conference Series*, *1529*(4), 042065. https://doi.org/10.1088/1742-6596/1529/4/042065

Fang, L., & Chen, S.-C. (2019). Enhancing the learning of history through VR: The thirteen factories Icube experience. In *Digital Turn in Schools—Research, Policy, Practice* (pp. 37–50). Springer Singapore. https://link.springer.com/chapter/10.1007/978-981-13-7361-9_3 https://lens.org/154-931-854-942-49X

Fordham, M. (2012). Disciplinary history and the situation of history teachers. *Education Sciences, 2*(4), 242-253. doi:10.3390/educsci2040242

Fuchs P., Moreau G., & Guitton, P. (Eds.) (2011). *Virtual reality: concepts and technologies*. CRC Press, Boca Raton, FL.

Gaitatzes, A., Christopoulos, D., & Roussou, M. (2001). Reviving the past: Cultural heritage meets virtual reality. *Proceedings of the 2001 Conference on Virtual Reality, Archeology, and Cultural Heritage*, 103–110. https://doi.org/10.1145/584993.585011

Ghida, B. (2020). Augmented reality and virtual reality: A 360° immersion into western history of architecture. *International Journal of Emerging Trends in Engineering Research*, *8*(9), 6051–6055. https://doi.org/10.30534/ijeter/2020/187892020

Gopalan, M., Rosinger, K., & Ahn, J. B. (2020). Use of Quasi-Experimental Research Designs in Education Research: Growth, Promise, and Challenges. *Review of Research in Education*, *44*(1), 218–243. https://doi.org/10.3102/0091732X20903302

Greenbaum P. (1992). The lawnmower man. *Film Video* 9, (3), 58–62

Gregory, S., Gregory, B., Reiners, T., Fardinpour, A., Hillier, M., Lee, M., Jacka, L., Butler, D., Holloway, D., & Grant, S. (2013). Virtual worlds in Australian and New Zealand higher education: Remembering the past, understanding the present and imagining the future. Electric Dreams-Ascilite 2013 Conference Proceedings Sydney.

Guimarães, M. de P., Silva, E. de M., Faria, A. dos S., Argollo-Ferrão, A. M. de, & Dias, D. R. C. (2022). A multisensory (visual, auditory, and olfactory) and teaching application concerning the history and production process of coffee. *Simpósio de Realidade Virtual e Aumentada (SVR)*, 26–27. https://doi.org/10.5753/svr_estendido.2022.227649

Heim, M. R. (2017). Virtual reality wave 3. In *Boundaries of self and reality online* (pp. 261–277). Elsevier.

Horn, T. C. R., & Ritter, H. (1986). Interdisciplinary history: A historiographical review. *The History Teacher, 19*(3), 427-448.

Huaman, E. M. R., Aceituno, R. G. A., & Sharhorodska, O. (2019). Application of Virtual Reality and Gamification in the Teaching of Art History. In *Learning and*

Collaboration Technologies. Ubiquitous and Virtual Environments for Learning and Collaboration (pp. 220–229). Springer International Publishing.

Husbands, C. (2011). What do history teachers (need to) know?: A framework for understanding and developing practice. In D. Ian (Ed.), *Debates in history teaching* (pp. 84-95). London: Routledge.

Hutson, J., & Fulcher, B. (2022). A Virtual reality educational game for the ethics of cultural heritage repatriation. *Games and Culture*,*8*(6) https://doi.org/10.1177/15554120221131724

Hutson, J., & Olsen, T. (2022). Virtual reality and art history: A case study of digital humanities and immersive learning environments. *Journal of Higher Education Theory and Practice*, *22*(2). https://doi.org/10.33423/jhetp.v22i2.5036

Ibrahim, A., Al-Rababah, A. I., & Bani Baker, Q. (2021). Integrating virtual reality technology into architecture education: The case of architectural history courses. *Open House International*, *46*(4), 498–509. https://doi.org/10.1108/ohi-12-2020-0190

ICT Capacity Building (2005). ICT in secondary education in the Pacific region: status trends and prospects. Suva, Fiji: ICT Capacity Building at USP Project, University of the South Pacific, 2005

Ijaz, K., Bogdanovych, A., & Trescak, T. (2016). Virtual worlds vs books and videos in history education. *Interactive Learning Environments*, *25*(7), 904–929. https://doi.org/10.1080/10494820.2016.1225099

Imran, M. (2023). Recreating lost worlds: enhancing archaeological research through comprehensive digital reconstruction with virtual reality and GIS technologies. *Qeios*. https://doi.org/10.32388/rd8rno

Kazanidis, I., Palaigeorgiou, G., Chintiadis, P., & Tsinakos, A. (2018). A pilot evaluation of a virtual reality educational game for history learning. *European Conference on E-Learning*, 245–253. https://www.proquest.com/docview/2154984770/abstract/890BC57EF46C4C7EPQ/1

Lacko, J. (2019). Cultural heritage objects in education by virtual and augmented reality. In *Augmented Reality and Virtual Reality* (pp. 175–187). Springer International Publishing. https://link.springer.com/chapter/10.1007%2F978-3-030-06246-0_13 https://lens.org/035-220-800-264-245

Lewis, R., & Taylor-Poleskey, M. (2021). Hidden town in 3D. *Journal on Computing and Cultural Heritage*, *14*(2), 1–14. https://doi.org/10.1145/3431924

Li, L., & Li, Q. (2022). Research on the education of party history based on virtual reality. *International Journal of Education and Humanities*, *5*(2), 49–53. https://doi.org/10.54097/ijeh.v5i2.2102

Lorusso, M. L., Travellini, S., Giorgetti, M., Negrini, P., Reni, G., & Biffi, E. (2020). Semi-immersive virtual reality as a tool to improve cognitive and social abilities in Preschool children. *Applied Sciences*, *10*(8), Article 8. https://doi.org/10.3390/app10082948

Lowood, H. E. (2023, December 14). *Virtual reality*. *Encyclopedia Britannica*. https://www.britannica.com/technology/virtual-reality

Malik, U. S., Tissen, L., & Vermeeren, A. (2021). 3D reproductions of cultural heritage artifacts: Evaluation of significance and experience. *Studies in Digital Heritage*, *5*(1), 1–29. https://doi.org/10.14434/sdh.v5i1.32323

Malysheva, O., Tokareva, E., Orchakova, L., & Smirnova, Y. (2022). The effect of online learning in modern history education. *Heliyon, 8*(7),1-11

Maulana, H., & Khansa, R. A. (2019). Virtual reality application for educational interactive media “3 historical monuments of Yogyakarta.” *Journal of Physics: Conference Series*, *1193*(1), 012019. https://doi.org/10.1088/1742-6596/1193/1/012019

Mayer, R. H. (2006). Learning to Teach Young People How to Think Historically: A Case Study of One Student Teacher's Experience. *The Social Studies, 97*(2), 69-76. https://doi.org/10.3200/TSSS.97.2.69-76

Mohsen, H., Tohme, M., & Nashi, R. (2023). From passive to immersive: Metaverse as a pedagogical approach in history class—Presenting a constant reminder of historical remnants and a customizable reality for future preferences; Beirut as a case study. *Architecture and Planning Journal (APJ)*, *28*(3). https://doi.org/10.54729/2789-8547.1233

Moseikina, M., Toktamysov, S., & Danshina, S. (2022). Modern technologies and gamification in historical education. *Simulation & Gaming*, *53*(2), 135–156. https://doi.org/10.1177/10468781221075965

Munslow, A. (2006). *The Routledge companion to historical studies (2nd ed.)*. London: Routledge.

Nachtigall, V., Yek, S., Lewers, E., Brunnenberg, C., & Rummel, N. (2022). Fostering cognitive strategies for learning with 360 degrees videos in history education contexts. *Unterrichtswissenschaft*, *50*(4), 615–638. PubMed-not-MEDLINE. https://doi.org/10.1007/s42010-022-00154-x

Neves, L., & Pombo, F. (2021). Virtual Reality for interior design history. The Ofir house as experimental project. In *Advances in Design, Music and Arts* (pp. 461–471). Springer International Publishing. https://link.springer.com/chapter/10.1007/978-3-030-55700-3_32 https://lens.org/185-340-315-540-061

Nurfahrul Lukmanul Khakim, M., & Djoko Sulistyo, W. Y. (2023). Optimizing local history learning with the saloka application. *KnE Social Sciences, 8*(10), 338–352. https://doi.org/10.18502/kss.v8i10.134

Oppong, C. A, & Quan-Baffour, K. P. (2014). The nature of historical facts: History teachers' conception of it. *Journal of Education and Practice, 5*(29), 136-143.

Oppong, C., Adjepong, A., & Boadu, G. (2022). Practical history lessons as a tool for generating procedural knowledge in history teaching. *Yesterday and Today, 27*, 143-161. https://doi.org/10.17159/2223-0386/2022/n27a6

Owusu-Ansah. R. (2011). *The declining popularity of history as a subject in the senior high schools in the Central Region, Ghana*. Unpublished Master's dissertation, Department of Arts and Social Sciences Education (DASSE), University of Cape Coast, Cape Coast, Ghana.

Parkes, R. J., & Donnelly, D. (2014). Changing conceptions of historical thinking in history education: an Australian case study. *Revista Tempo e Argumento, 6*(11), 113-136. https://doi.org/10.5965/2175180306112014113

Parkes, R. J., & Donnelly, D. (2014). Changing conceptions of historical thinking in history education: An Australian case study. *Revista Tempo e Argumento*, *6*(11), 113-136. https://doi.org/10.5965/2175180306112014113

Parong, J., & Mayer, R. E. (2021). Cognitive and affective processes for learning science in immersive virtual reality. *Journal of Computer Assisted Learning*, *37*(1), 226–241. https://doi.org/10.1111/jcal.12482

Pickering, C., & Byrne, J. (2014). The benefits of publishing systematic quantitative literature reviews for PhD candidates and other early-career researchers. *Higher Education Research & Development, 33*(3), 534–548.

Pickering, C., Grignon, J., Steven, R., Guitart, D., & Byrne, J. (2015). Publishing not perishing: How research students transition from novice to knowledgeable

using systematic quantitative literature reviews. *Studies in Higher Education, 40*(10), 1756–1769.

Razuvalova, E., & Nizamutdinov, A. (2015). Virtual reconstruction of cultural and historical monuments of the Middle Volga. *Procedia Computer Science*, *75*, 129–136. https://doi.org/10.1016/j.procs.2015.12.229

Remolar, I., Rebollo, C., & Fernández-Moyano, J. A. (2021). Learning history using virtual and augmented reality. *Computers*, *10*(11), 146. https://doi.org/10.3390/computers10110146

Rheingold, H. (1991). Virtual reality. NY*: Summit Books*.

Smith, A. (2011). Big society? better history? Or same old nonsense? Drawing the battle lines for the future of school history. *Forum, 53*(1), 129-144. http://doi.org/10.2304/forum.2011.53.1.129

Štemberger, T., & Cencič, M. (2016). Design based research: The way of developing and implementing educational innovation. *World Journal on Educational Technology*, *8*. https://doi.org/10.18844/wjet.v8i3.621

Sulistiono, W. E., Muhammad, M. A., Andrian, R., Martinus, Nama, G. F., Ghuffrony Rezaldhy, S., Annisa, R., Mulyani, Y., & Djausal, A. N. (2021). *Virtual reality as learning media for Lampung historical heritage*. 14–18. https://doi.org/10.1109/iccteie54047.2021.9650626

Sutherland, I. E. (1965). The ultimate display. In *Proceedings of the Congress of the International Federation of Information Processing (IFIP)* (Vol. 2, pp. 506–508)

Tang, F. (2024). Understanding the role of digital immersive technology in educating the students of English Language: Does it promote critical thinking and self-directed learning for achieving sustainability in education with the help of teamwork? *BMC Psychology*, *12*(1), 144. https://doi.org/10.1186/s40359-024-01636-6

Taranilla, V., R., Cózar-Gutiérrez, R., González-Calero, J. A., & López Cirugeda, I. (2019). Strolling through a city of the Roman Empire: An analysis of the potential of virtual reality to teach history in Primary Education. *Interactive Learning Environments*, *30*(4), 608–618. https://doi.org/10.1080/10494820.2019.1674886

Tarng, W., Su, Y.-C., & Ou, K.-L. (2023). Development of a virtual reality memory maze learning system for application in social science education. *Systems*, *11*(11), Article 11. https://doi.org/10.3390/systems11110545

Taylor, T., & Young, C. (2003). *Making history: A guide for the teaching and learning of history in australian schools.* Commonwealth of Australia.

Toktamysov, S., Alwaely, S. A., & Gallyamova, Z. (2022). Digital technologies in history training: The impact on students` academic performance. *Education and Information Technologies*, *28*(2), 2173–2186. https://doi.org/10.1007/s10639-022-11210-5

Tucker, E. (2013). The subject of history: Historical subjectivity and historical science. *Journal of the Philosophy of History, 7*, 205-229.

VanSledright, B. A. (2004). What does it mean to think historically… and how do you teach it. *Social education*, *68*(3), 230-233.

Wineburg, S. (2010b). Teaching historical thinking using primary sources. *Teaching With Primary Sources Quarterly, Winter*, 2-3.

Wong, C. S. K., Lu, A., Im, T. S. W., & Cheung, R. Y. H. (2019). Supporting flipped learning with virtual-reality field trips. 2019 International Symposium on Educational Technology (ISET), Hradec Kralove, Czech Republic, 2019, pp. 54-59 https://doi.org/10.1109/iset.2019.00021

Wu, W., Yen, H., & Chen, J. (2020). The influence of virtual reality learning system on the learning attitudes of design history. In *Proceedings of the 8th International Conference on Kansei Engineering and Emotion Research* (pp. 284–291). Springer Singapore. https://link.springer.com/chapter/10.1007/978-981-15-7801-4_30 https://lens.org/042-216-764-300-465

Yildirim, G., Elban, M., & Yildirim, S. (2018). Analysis of use of virtual reality technologies in history education: A case study. *Asian Journal of Education and Training*, *4*(2), 62–69. https://doi.org/10.20448/journal.522.2018.42.62.69