

A Systematic Review of Virtual Reality/Augmented Reality Technology for History Teaching

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Virtual reality (VR)/augmented reality (AR) technology, as an emerging educational technology, has the characteristics of immersion, interaction and imagination. It supports students to carry out meaningful learning in the learning process and can effectively promote the development of higher-order thinking (Villena Taranilla R,2019). Under the influence of the epidemic, history research travel is restricted (Chan C-S,2021). Traditional history teaching is mainly based on multimedia courseware and history textbooks, and fragments of historical material excerpts are mostly used. Students can only observe leopard by speckle, and it is difficult to penetrate into historical details (Yang Fan,2021). Virtual reality (VR)/augmented reality (AR) technology can create virtual educational situations and present rich historical materials for students, so as to overcome the teaching difficulties of abstract historical knowledge. In addition, VR/AR technology provides rich resources and convenient space for students to develop higher-order thinking, gives full play to students' dominance and greatly improves the effect of history teaching (Chen Huaming et al., 2019). According to the existing literature, current studies mainly focus on the application of virtual reality technology in medical education, experimental teaching, virtual campus and other aspects (Tong Ling et al., 2020), and few literatures review the specific application of VR/AR technology in the practice of history teaching. Therefore, this paper searched "CNKI" and "Web of Science" databases related to the application of VR/AR technology in history teaching. According to the data statistics of selected literature, this paper analyzes the research status, application form, history teaching method and learning effect of VR/AR in history teaching, and summarizes the research hotspots and development trend of VR/AR in history teaching. On this basis, this paper puts forward some suggestions for the application of VR/AR technology in history teaching, in order to optimize the design of history teaching activities and improve the effect of history teaching.

Keywords: Virtual reality, Augmented reality Learning effect, Research subject

1. Introduction

The "Thirteenth Five-Year Plan" for Educational Informatization and "Key Points of Educational Information Work in 2017" issued by the Ministry of Education of China listed virtual reality as the key point, and the promotion of VR education is the general trend. At this stage, the application fields of virtual reality technology mainly include skills training in vocational education (Tai K-H et al., 2022), English and other language disciplines (Xie Y et al., 2021), digital museums (Chen Juanjuan et al., 2021) and other natural disciplines. Humanities and cultural dissemination are combined more, such as applying VR technology to the study of party history knowledge (Zhou Zhaowen, 2021), Tsinghua University Optical Disc Engineering Research Center realizes large panoramic VR production of Potala Palace (Yang Jiangtao, 2015), The application of AR technology to the publicity and display of Chinese historical allusions is moderate (Lin Yanan et al., 2021). To sum up, there is little practice of combining VR/AR

technology with humanities teaching, especially in history education (Tong Ling et al., 2020). Although domestic and foreign educational research on virtual reality technology has turned to history classrooms, the overall research volume has not achieved a qualitative change (Chen Huaming et al., 2019). History education can not only cultivate patriotism, but also improve humanistic quality, develop higher-order thinking ability, and correct students' values, which is of great significance (Chen Huaming et al., 2019). In the history education in the post-epidemic era, the combination of VR/AR technology and offline history teaching can break the limitation of time and space, and promote the reform of history classroom by restoring historical scenes and events to improve teaching efficiency (Wang Yugong, 2021). At present, many researchers have paid attention to the development and application process of VR/AR technology in history, but there is a lack of research and discussion on the research status, application form, learning effect, and teaching practice of VR/AR technology in the history teaching process. . Therefore, this study intends to answer the following questions by sorting out and analyzing the empirical research results of applying VR/AR technology in history teaching:

RQ1: From 2011 to 2021, what is the research status of VR/AR technology in history teaching? What are the main journals and papers for the research? Which countries are you from?

RQ2: From 2011 to 2021, what is the application form of VR/AR technology in history teaching?

RQ3: From 2011 to 2021, with the support of VR/AR technology, how will the history subject be taught and designed?

RQ4: From 2011 to 2021, with the support of VR/AR technology, what is the current status of the learning effect in history teaching?

RQ5: From 2011 to 2021, what are the research topics on the application of VR/AR technology in history teaching? What is the evolution history of the research topic?

2. Research Design & Methods

2.1 Literature Review

2.1.1 Virtual reality

Virtual reality technology mainly covers immersive virtual reality (VR), augmented reality (AR) and mixed reality (MR) technology (Cui Yuting, 2020). Luo Heng et al. (2021) pointed out that many scholars did not distinguish between virtual reality and augmented reality in their review research, ignoring the impact of different technical characteristics on the learning experience. VR refers to computer technology as the core, combined with big data, artificial intelligence, sensor technology, etc., to generate a digital virtual learning environment that is highly similar to the real environment in terms of vision, hearing, touch, etc. (Zhang Jianwu, 2010). AR refers to superimposing or synthesizing virtual objects on the basis of reality (Azuma R T, 1997), superimposing digital content on physical objects through mobile devices to enhance the understanding of real content. In short, VR puts students in the virtual world, emphasizing the sense of presence brought by digital media; AR superimposes information or virtual objects into the real world, emphasizing the coexistence of virtual and reality (Luo Heng et al., 2021).), there is a clear difference between the two.

2.2 The advantages of VR/AR technology in the field of history teaching

Traditional history teaching is mainly based on the "transmit-receive" model, which only focuses on the mastery and application of students' knowledge, but ignores the cultivation of students' autonomous learning ability and exploration ability (Yang Wenhui, 2015). The application of VR/AR technology to the study of history subjects can effectively solve the above problems. First, VR/AR technology can transform

the boring historical knowledge in textbooks into highly simulated virtual scenes, thereby enhancing students' understanding and memory of declarative knowledge in history subjects (Tong Ling, 2020); secondly, the study of historical knowledge It is not only limited to memorizing textbook knowledge, especially in the basic education stage, teachers should pay more attention to cultivating students' feelings of home and country, so that students can form correct values. In the virtual historical environment created by VR/AR technology, students can cultivate patriotism through character experience and other methods, enrich emotional experience and establish correct three views. Finally, virtual reality technology can simulate and reproduce historical figures to a high degree. For example, in the teaching of junior high school history, students can interact with virtual Yuanmou people, Beijing people, etc. to understand knowledge other than textbooks, which is conducive to promoting students' self-learning ability improve students' creative thinking (Yang Wenhui, 2015).

3. Research Method

3.1 Literature search

In this study, we searched relevant literature on the application of VR/AR technology to history learning in relevant databases. The foreign literature is mainly based on the Web of Science core collection database, and the domestic literature is mainly based on the CNKI database.

The selection of search keywords refers to what Luo Heng et al. ^[9] proposed: an arbitrary combination of two sets of keywords is used as a search string. At the same time, relevant content in line with the theme of this study was included to expand the amount of literature that was initially screened. Finally, the first set of search strings in the domestic literature is "virtual reality technology/augmented reality technology/virtual technology" and the English abbreviation "VR/AR", and the second set of search strings are specific educational contexts such as: history, history education, history Teaching, history learning, etc.

The first set of search strings for foreign literature is "VR/AR", and the second set of search strings is history, history teaching, history learning, history education, etc. A total of 74 Chinese and English literatures were obtained through initial screening by reading article titles and keywords. According to the research topic, this paper further selects the preliminary screening literature and finally obtains 24 qualified empirical studies.

3.2 Literature screening

The literature analyzed in this study mainly focuses on the application of virtual reality technology and augmented reality technology in historical learning, and has a complete teaching process and measurement of subsequent learning outcomes. Therefore, this study selects them according to the following criteria. First, there is a need for research in the field of history teaching, which excludes literature such as science, medicine, mathematics, and art teaching. Second, empirical research is needed, which excludes literature such as case analysis, meta-analysis, and theoretical analysis. Third, there is a need for complete instructional design and procedures, which excludes literature on museums, libraries, outdoor environment simulations, etc. Fourth, the use of virtual reality technology and augmented reality technology excludes literature such as 2D educational videos or educational games. Fifth, the content of the literature must be fully accessible. According to the above screening criteria, this study followed the screening process shown in the figure above, and finally obtained a total of 24 sample literatures.

3.3 Coding system

In this study, vos viewer and excel software were used to analyze the data of 24 sample documents. On this basis, the sample document data was divided into five parts. First, the current research status, including the source of the literature and the year and region of publication; second, the Application form, including technology type (AR/VR technology), device type (computer, VR helmet, VR glasses, mobile device, etc.) and combination form (scene-based, guided tour, interactive experience, etc.) (Chen Juanjuan et al., 2021); Third, teaching design, including teaching objects, teaching functions, teaching content, teaching methods, etc. (Luo Heng et al., 2021). Fourth, effect evaluation, including conceptual knowledge acquisition, operational skills acquisition, and perceived gain (Chen Juanjuan et al., 2021); fifth, research topics (history teaching situations supported by VR/AR, design and development of history teaching resources, etc.) and analysis of development trends.

4. Results

4.1 Research status

4.1.1 Year and country of publication

①From the year of publication, the 24 sample papers were all published between 2011 and 2021. Figure 2 shows the publication of empirical research literature on the application of virtual reality technology to history learning from 2011 to 2021. It can be seen that between 2011 and 2021, 2 articles were published in 2011, 3 articles were published in 2012, 2 articles were published in 2015, 1 article was published in 2016, 3 articles were published in 2017, and 1 article was published in 2018. 4 papers will be published in 2019, 4 papers will be published in 2020 and 2021 respectively. ②From the perspective of the regions where the literature was published, China (6 articles) ranked first, Australia, the United States, Spain, Singapore, the United Kingdom, and Taiwan, China all published 2 articles, and Poland, Canada, Greece, Italy, India, and Chile all published 1 article. The regional distribution of publications is shown in Figure 3. To sum up, it can be seen that the relevant empirical research on the application of VR/AR technology to history teaching shows a trend of gradual increase, especially in the past three years, the number of relevant literature publications has increased rapidly. But in general, the number of publications is not large, and there are few empirical research literatures, and most of the literatures are mainly non-empirical research. Chinese scholars have done more research in this area, and the quality of the literature is relatively high, mainly master and doctoral theses. In addition, scholars in Australia, the United States, Taiwan and other regions have also begun to gradually pay attention to the research in the field of history. In short, the application of VR/AR technology in history teaching needs more and more in-depth exploration by scholars.

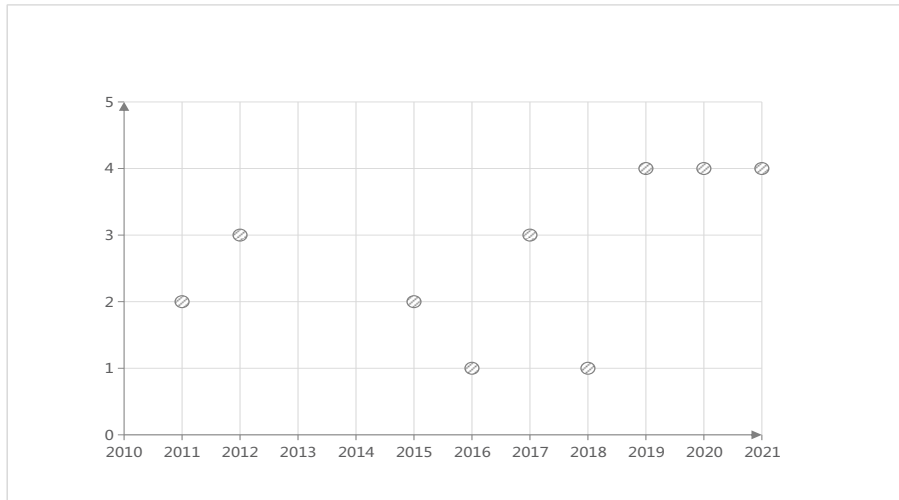


Figure1.
Distribution map of publication years

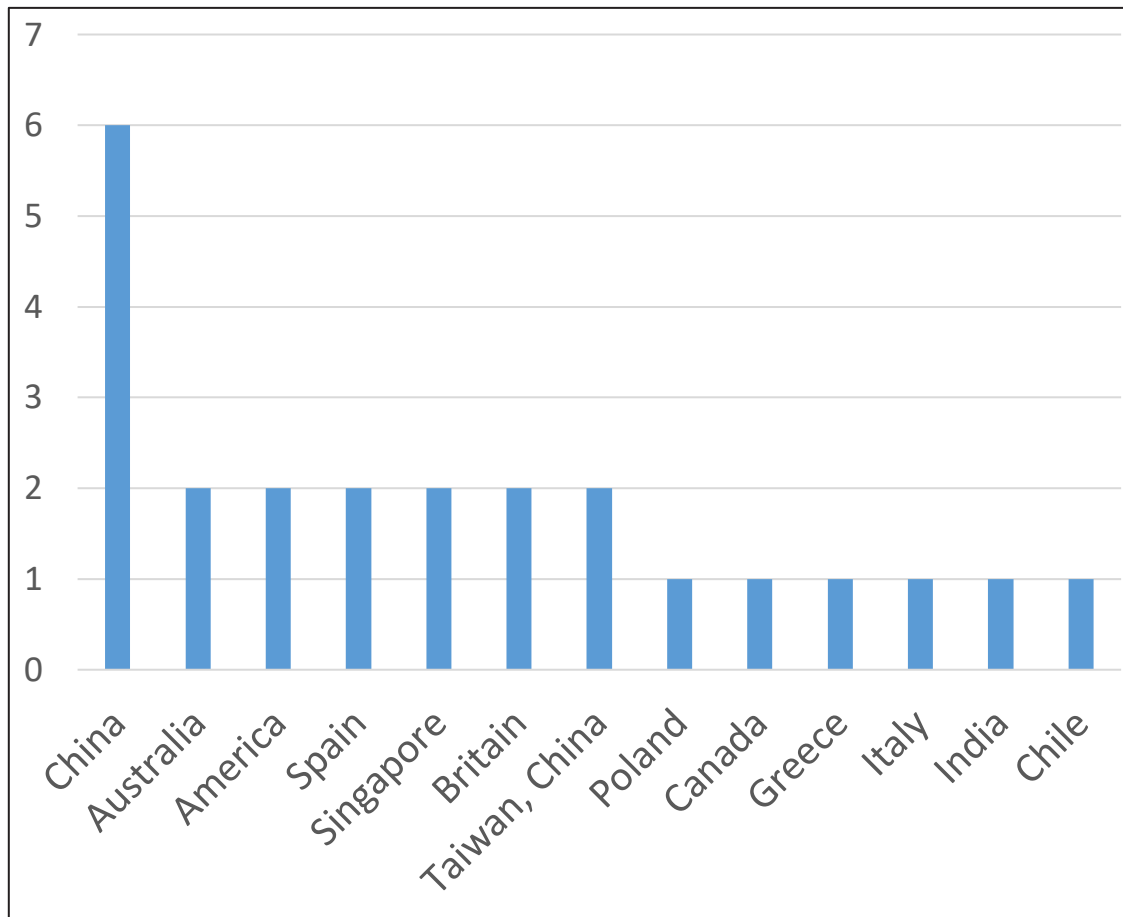


Figure 2.
Distribution map of publication years

4.1.2 Publication trends

By analyzing the application research of VR/AR technology in history teaching published in the web of science-SSCI database, 18 English literatures came from 10 journals, as shown in Figure 3. Among them, 5

articles came from the journal "INTERACTIVE LEARNING ENVIRONMENTS", ranking first in the list. Followed by "COMPUTERS EDUCATION" (4 pieces), "BRITISH JOURNAL OF EDUCATION TECHNOLOGY" (1 piece), "COMPUTER IN HUMAN BEHAVIOR" (1 piece) and so on.

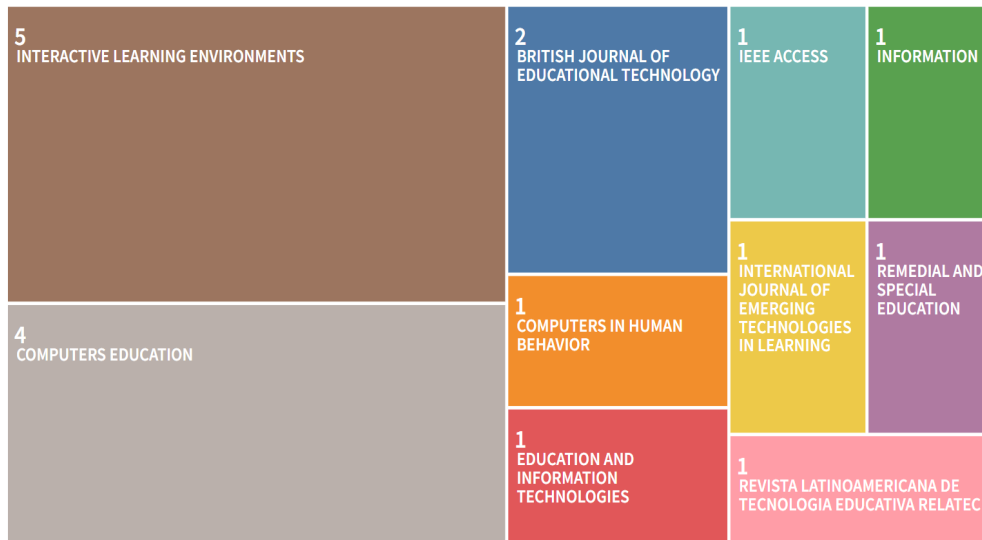


Figure 3.

Distribution of foreign journals in which VR/AR technology is applied to history teaching and research

In addition, there are few domestic researches on the application of virtual reality technology in history teaching, and most of the literatures are mainly non-empirical research. After the search, the author obtained a total of 6 domestic literatures, including 3 master thesis and 2 journals. Papers, 1 is a conference paper.

4.2 Application form

4.2.1 Type of technology

Among the 24 papers selected by the author, 70% (16 papers) used VR technology, and 30% (8 papers) used AR technology. For example, Chan C-S et al. (2021) applied VR technology to remote architectural history teaching, Li Fei et al. (2019) applied historical VR learning software to the history teaching of the Western Han Silk Road, Tzima S et al. (2020) used AR technology Restoring old church ruins and designing historical escape games help students experience. Judging from the number of documents, VR technology is widely used in the research on the field of history learning. This may be related to the particularity of history teaching. Abstract knowledge such as historical figures, historical events, and historical systems in history textbooks is the main teaching content. Compared with AR technology, VR technology can overcome the teaching difficulties of abstract historical knowledge by creating situations and experiencing virtual worlds, and improving students' learning effect by controlling the sense of presence in the teaching process (Chen Huaming, 2019).

4.2.2 Device Type

The most used VR/AR technology in history teaching is computer (9 articles), which is mainly because computers are more convenient to use in schools and can provide a learning environment with a strong sense of immersion; followed by mobile devices (7 articles), usually It is operated with the support of the mobile phone or tablet application program, which is easy to carry; the computer is used in combination with the VR helmet (5 articles), and a handle is usually provided to facilitate students' interactive experience, and the computer and mobile devices are used in combination (2 articles) , VR headset alone (1 article), mobile device and VR glasses combined (1 article).

4.2.3 Combined form

Among them, the most common combination is based on scenes (12 articles), which provide scenes related to historical events. Students can visit the virtual museum (Okolo CM. et al., 2020), pyramids (Shi Yilin, 2010), Italian urban architecture (Puggioni M et al., 2021), ancient Roman architecture (Villena Taranilla R et al., 2019), etc., to achieve immersive experience, so as to deeply understand historical knowledge. The second is the interactive experience (7 articles), mainly based on historical educational games and answering test modes. Historical educational games include: historical escape games (Tzima S et al., 2019), historical role-playing games (Fassbender E et al., 2012)). The answering test is conducted in the form of knowledge checkpoints embedded in virtual reality devices (Wu W-L et al., 2021). In addition, based on the guided tour (6 articles), the relevant historical information is mainly presented by scanning buildings or models, etc., and students are assisted in learning according to the teaching support provided.

4.3 Teaching Design

4.3.1 Teaching content

With the support of VR/AR technology, the content of history teaching is mainly textbooks (14 articles), including: urban history in the Renaissance, general history of universities (psychology history, art history, general history), historical events and other historical education content, For example, Yang Wenhui (2015) presents a virtual museum of ancient human fossils through VR technology. In the process, students experience primitive farming life and develop a deep understanding of knowledge. The second is architectural history (9 articles), mainly for students to learn history by visiting virtual buildings. Including: old church ruins (Tzima S et al., 2020), Wanjin Church in Taiwan, China (Shih J-L et al., 2015), buildings in San Diego (Joo-Nagata J et al., 2017), etc. In addition, there are two articles that do not clearly state the specific content of history teaching.

4.3.2 Teaching objectives

As a kind of teaching media, the teaching function of VR/AR technology in the history subject is mainly based on situational experience (14 articles). Students experience in the virtual teaching situation and have a profound feeling of the relevant historical culture. The second is content teaching (10 articles), teachers teach historical knowledge with the support of VR/AR technology, and stimulate students' interest in historical learning. In addition, help students develop the ability to analyze and solve historical problems (1 article). Okolo CM et al. (2010) developed a virtual museum about President Jackson. After the students visited, they thought and gave reasons about whether Jackson was a people or a dictator, so as to cultivate students' ability of historical reasoning and reasoning and problem-solving.

4.3.3 Use objects

Figure 4 shows the distribution of teaching objects in the 24 empirical studies, among which the teaching objects are college students (12), middle school students (8), primary school students (3), college students and other groups as subjects (1.), other social groups (1 article).

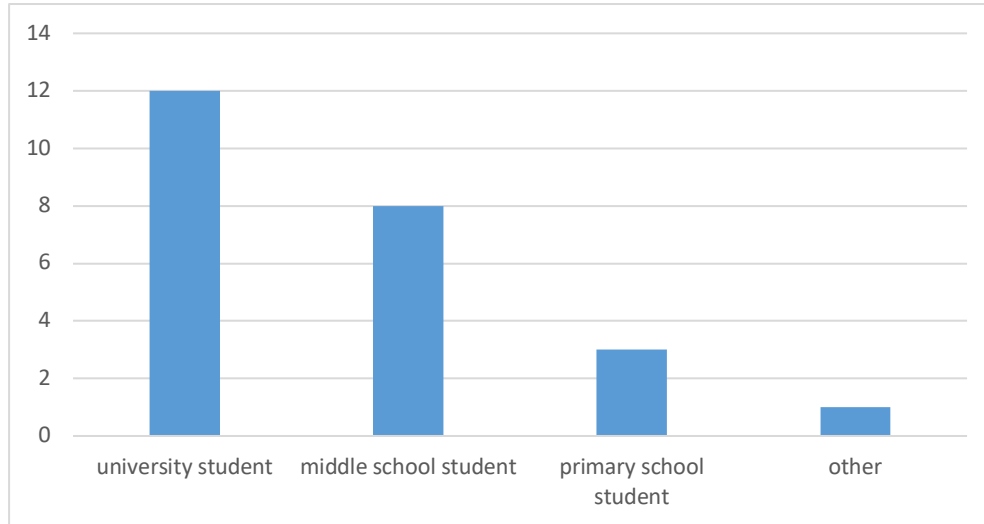


Figure 4.
Distribution of different teaching objects

4.4 Effect evaluation

With the support of VR/AR technology, the dimensions and methods of measuring historical learning effects are shown in the following table (some articles measure different categories of the same dimension, and the measurement methods can include multiple, so the cumulative number of articles is repeated) , among the 24 selected samples, 15 measured conceptual knowledge acquisition. Further analysis of the literature data shows that researchers usually use the knowledge test scores after the completion of history teaching to evaluate learners' conceptual knowledge memory acquisition. Case. Among them, some researchers use APP test questions to understand students' knowledge mastery (Tzima S et al., 2020), and some researchers use virtual reality technology to embed test questions to evaluate students' learning (Warburton S, 2009) . In addition, some researchers used the form of questionnaires.

Among the 24 selected sample literatures, 19 measured skill acquisition, mainly through questionnaires, interviews, tests and other forms to allow students to evaluate their learning. Skills cover higher-order thinking abilities (innovative thinking, argumentative thinking, critical thinking, etc.), problem-solving abilities (historical knowledge inquiry ability, historical knowledge transfer ability, historical appreciation ability, etc.), team learning ability (cooperation and communication ability, etc.). Among them, higher-order thinking ability is measured by questionnaire (Yang Wenhui, 2015), and some researchers evaluate it by observing and analyzing students' behavior (Martinez Soto JM et al., 2018).

Among the 24 selected sample literatures, 15 have measured perceived gain. Most studies use questionnaires as measurement tools, and some studies use interviews and observations to measure learners. of perceived gains. Among them, the most measured are learning interest and satisfaction, that is,

learners' attitude towards historical learning supported by VR/AR technology, willingness to learn again, and suggestions for improvement in instructional design; Chan C-S et al. (Chan C-S et al., 2021) passed Analysis of the questionnaire results revealed that the students would like to further render the images, enhance the details and shading to improve the VR model. The second is immersion, which is the degree of empathy and engagement of learners with historical events or characters; Li Fei (2019) used a questionnaire to measure the flow state of learners during the learning process to evaluate their immersion. 1 sample literature used questionnaires and interviews to measure learners' vertigo, and 2 people experienced obvious physical discomfort during the VR environment experience (Li Fei, 2019).

4.5 Research Topics

In this study, 18 English sample documents and 6 Chinese documents were selected for keyword co-occurrence analysis using vos viewer software, as shown in Figure 5. In this visual network diagram, items are represented by circles, each circle represents a keyword, and the size of the circle is determined by the number of times the keyword appears. The higher the frequency of occurrence.

In the research on the application of VR\AR technology in history teaching abroad, there are a total of 84 author keywords. After merging synonyms, a total of 20 keywords are presented in the visual network diagram. After co-occurrence analysis by vos viewer, 20 author keywords The words are divided into 3 clusters, the first cluster of VR technology and educational situations and elements (keywords = 12), the second cluster of AR technology specific teaching content and media (keywords = 4), the third cluster of historical teaching effects and tools (keywords=4). As can be seen from Figure 5, the most commonly used keywords include, AR technology, VR technology, educational games, cultural heritage, history, historical learning, etc. From the thickness of the connection between keywords, it can be concluded that the practice of VR technology in history teaching is usually combined with collaborative learning and educational games, and AR technology is usually studied in combination with cultural heritage and mobile devices in history teaching.

In the domestic research on the application of VR\AR technology to history teaching, there are a total of 31 keywords. After merging synonyms, a total of 11 keywords are presented in the visual network map, as shown in Figure 6. After co-occurrence analysis of vos viewer software, 11 keywords are divided into 3 clusters, the first cluster is virtual reality, junior high school history, teaching scenarios, unity3d (keyword = 4), the second cluster is history teaching, auxiliary teaching, Virtual simulation experiments, etc. (keyword=4), the third cluster is history education, learning software, and flow experience (keyword=3). It can be seen that the most frequent keywords are virtual reality and history teaching. From the thickness of the connection between the keywords, it can be seen that virtual reality technology is usually associated with VR development software such as teaching scenarios and unity3d, and at the same time, it also pays attention to the learning effect of students, such as flow experience.

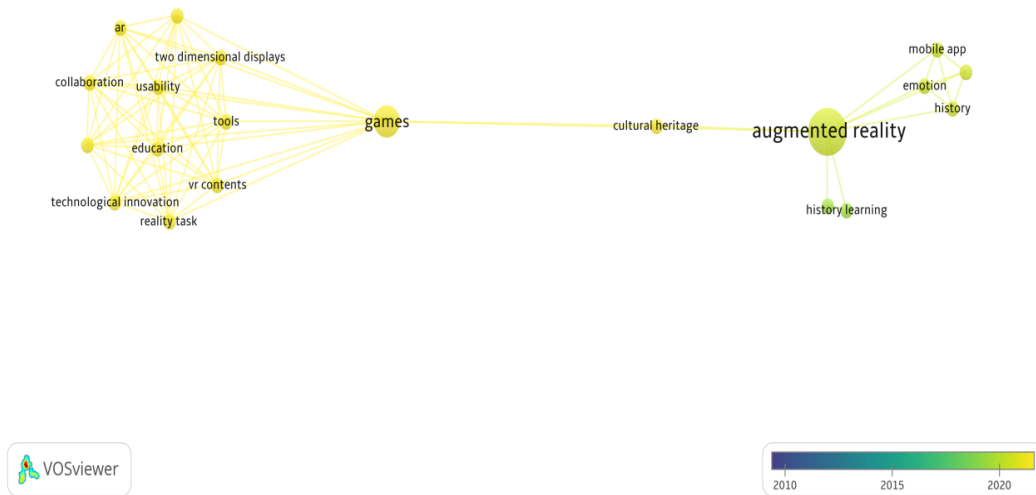


Figure 5.
Co-occurrence analysis of author keywords in the application of foreign VR\AR technology to history teaching research from 2011 to 2021

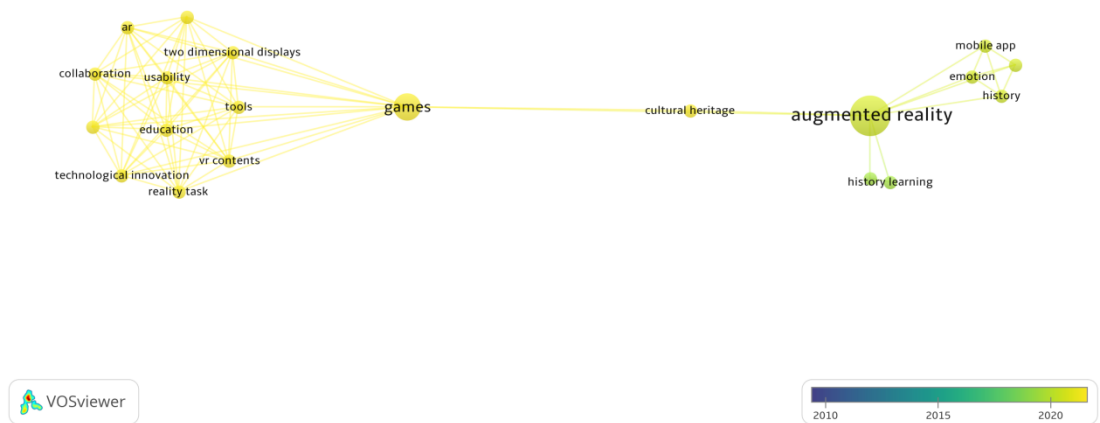


Figure 6.
Keyword co-occurrence analysis of domestic VR\AR technology applied to history teaching research from 2011 to 2021

5. Discussion and Conclusion

5.1 Development trend

From the research on the application of VR\AR technology in history teaching at home and abroad from 2011 to 2021, it can be found that the application of virtual reality technology in history teaching has become more and more extensive in the past decade. First, the research content is not only limited to the history teaching in the classroom, but even gradually extended to the study of historical and cultural monuments. Second, in terms of research and innovation, we should pay more attention to the integration of virtual reality technology with educational games and self-adjusting learning strategies, so as to improve students' historical learning effect. Third, in terms of research tools, AR\VR technology is applied to mobile APPs, which reduces development costs and realizes technological innovation.

5.2 Existing problems and suggestions

This research analyzes the research status, application form, teaching design, and effect evaluation of VR/AR technology in history teaching by systematically arranging 24 sample documents. The development trend of VR/AR technology in historical learning. However, the analysis found that VR/AR technology has some problems in history teaching, such as: in the process of teaching practice, most of the teaching contents are mainly historical, cultural and historical sites, and rarely involve specific historical teaching materials, such as: middle school history teaching materials, university teaching materials History textbooks, etc.; secondly, due to the lack of effective teaching strategies, only using VR/AR equipment as a teaching medium has limited practical teaching effect. In addition, in the measurement of specific learning effects, most researchers focus on the acquisition of historical conceptual knowledge, and few people pay attention to the development of higher-order thinking such as historical reasoning, argumentative thinking, and critical thinking. In this regard, this study puts forward the following suggestions, in order to provide reference for the research of VR/AR technology in history learning: First, precision teaching: promote the deep integration of VR/AR technology and history textbooks. Second, use effective teaching strategies in a highly immersive VR/AR virtual teaching environment. Third, focus on the development of higher-order thinking in historical learning and explore appropriate measures.

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