Virtual Reality in Art Appreciation Education: A Systematic Review of The Literature

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Abstract: This study is a systematic review of 23 years of research on virtual reality (VR) usage in art appreciation education. A total of 34 articles were selected from 2 major academic databases using search strings and manual screening protocols. The literature analysis emphasized four aspects of VR-based art appreciation education: research methodologies, instructional design, technological affordances, and assessment. The results show the trends in the VR literature regarding the forms of application in different knowledge types, interaction design specific to art appreciation, and the solutions to the cognitive load imposed by the technology. Finally, practical implications and a future research agenda for VR-based instruction are discussed.

Keywords: art appreciation education, systematic review, virtual reality

Introduction

Art appreciation is the process of using prior experience and knowledge to “respond to a work of art, of interpreting and understanding the work in particular and the meaning of art in general” (Law, 2010, p. 94). It is a multifaceted channel that exposes learners to a wide range of disciplines (Law, 2010). With the fast development of technology, many researchers proved that technology can effectively improve learning outcomes in art appreciation education, such as using multimedia devices to present artworks, e.g., using computer screens to display images and videos of artworks, using audio devices to provide the narration of artworks, or providing websites for learning (Sun et al., 2022). Nowadays, the use of virtual reality (VR) equipment has become less expensive and more convenient, making VR a popular tool for art appreciation.

VR technology, or virtual reality technology, is an important development branch of computer simulation technology, which utilizes the computer simulation principle to create and experience the virtual world (Pan, 2016). In recent years, many VR-based education practices increasingly showed their significance in improving learning effectiveness. For instance,
Chang et al. (2022) embedded social learning theory in spherical video-based virtual reality for childbirth education training, which facilitated learners’ learning of specific concepts and expertise, and increased motivation and learning satisfaction. Chan et al. (2022) applied VR technology to distance learning of architectural history, where learners were able to freely visit historical buildings and directly experience objects and events that they would not normally have access to; such implementation also ensured safety, increased learner engagement, and motivation. In language learning, researchers found that the use of VR can reduce comprehension difficulties and cognitive load, thereby improving learners’ vocabulary, speaking, and writing skills (Huang et al., 2021; Jain et al., 2020). In addition, VR-based learning not only stimulated learners’ interest in learning and attracted their attention, but also enhanced their autonomy (Yeh & Lan, 2017). In this way, VR-based learning activities effectively prompted learners to explore on their own in learning scenarios, feel what they cannot feel in reality, and induced emotional experiences and physiological reactions that were missing in 2D media (Ding et al., 2018). In addition, through the interactive features of VR, learners not only gained virtual experiences but also knowledge content and immediate learning feedback (Wu et al., 2021), facilitating the acquisition and application of knowledge. To conclude, there were many successful cases of applying VR technology in the instruction of language, physics, and other subjects (Georgiou et al., 2021; Parong & Mayer, 2021).

Given the above characteristics and empirical findings of VR-based learning, some scholars started to explore the use of VR in art appreciation education. For example, to preserve the ruins of the northwestern palace of King Ashnu Nasirpal II, researchers used VR to construct virtual ruins in art and archaeology classes (Kim, 2006). However, empirical research that investigated the effect of VR on art education was still limited.

Due to the rich content and complexity of art appreciation, the choice of art appreciation content varied from researcher to researcher, with the most common themes such as appreciation of paintings, architecture, and folklore and Intangible culture. Furthermore, unlike other subjects, VR-based art appreciation education usually took place in informal learning environments, such as museums. Although a rich variety of contents and methods provided more potential for art appreciation classrooms, it was difficult for researchers to refer to the appropriate teaching tool and assessment methods. There was a need to systematically review the existing literature to synthesize effective designs, strategies, and assessment methods to facilitate the future implementation of VR-based art appreciation education.

To address such a research gap, this study reviewed 23 years of literature on VR-based art appreciation education with the following questions:

1. How did researchers study VR-based art appreciation education? What were the research methodologies?

2. What were the instructional designs employed for VR-based art appreciation education?

3. What were the essential technological affordances of VR-based art appreciation education?

4. How effective was the VR-based instruction for art appreciation education across studies, and how was it evaluated?
Method

Informed by the existing protocols for literature review and synthesis (Luo et al., 2021), this study employed a systematic review approach to locate, select, and analyze the relevant VR literature published between January 1, 2000 and November 30, 2023 to answer the research questions. During this period, a large number of research focusing on VR art appreciation emerged.

The initial literature search was conducted using two selected research databases, EBSCO (primary) and Chaoxing Discovery Database, focusing on the titles and abstracts regarding art appreciation education. This study randomly combined two clusters of keywords as search strings. The first cluster comprised only two items, “virtual reality” and its abbreviation “VR;” the second included signifiers of art appreciation education such as “Art,” “art appreciation,” “art education,” and “art class.” Typical search strings included “virtual reality OR VR AND art education OR teach* OR learn*” and “virtual reality OR VR AND art appreciation.” During the initial search (Figure 1), 288 articles were identified, of which, 212 were from the EBSCO database and 76 were from the Chaoxing Discovery Database. Next, a search criterion was developed to narrow down the selection during the manual screening process: (1) focused on art appreciation, despite the grade levels; (2) focused on VR, articles about AR and mixed reality were removed; and (3) focused on peer-reviewed journal articles and conference proceedings, including quantitative, qualitative, mixed-methods, design-based, theoretical and synthesis research. Records of missing full text were identified and removed from the search. After the manual screening, a total of 34 articles satisfied the search criteria and were included in the main library for further analysis. Next, the detailed content of each selected article was carefully reviewed and analyzed based on the coding scheme, as shown in Table 1. The table also lists codes for each category with brief descriptions.

Table 1

The analytical coding scheme and overview of selected articles

<table>
<thead>
<tr>
<th>Category</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research methodologies</td>
<td>Research type</td>
<td>Empirical (true-experiment/quasi-experimental/design-based/mixed/theoretical/synthesis)</td>
</tr>
<tr>
<td></td>
<td>Iteration</td>
<td>Not reported/one/over one round</td>
</tr>
<tr>
<td></td>
<td>Duration</td>
<td>Not reported/0-1w/1-2 w/2-6w/6-8 w/other</td>
</tr>
<tr>
<td></td>
<td>Sample size</td>
<td>0-50/50-100/100-150/above 150</td>
</tr>
<tr>
<td></td>
<td>Data source</td>
<td>Survey/paper test/interview/video or audio captures/content analysis/other</td>
</tr>
<tr>
<td></td>
<td>Data analysis</td>
<td>Difference (t-test/ANOVA/ MANOVA/ ANCOVA, non-parametric), associational (SEM/ regression/factor analysis), meta-analysis/ qualitative analysis/descriptive analysis</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Instructional design</th>
<th>Contexts</th>
<th>Formal (K-12/higher education)/informal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedagogy</td>
<td>Inquiry-based/collaborative/demonstration/embody/other</td>
<td></td>
</tr>
<tr>
<td>Scaffolding</td>
<td>Teacher-guided/computer-guided/Hybrid-guided/no scaffolding</td>
<td></td>
</tr>
<tr>
<td>Technology affordances</td>
<td>Equipment</td>
<td>head-mounted displays/computer/other</td>
</tr>
<tr>
<td>Immerison</td>
<td>Full immersion/semi-immersion</td>
<td></td>
</tr>
<tr>
<td>Imagination</td>
<td>Fantasy world/realistic world</td>
<td></td>
</tr>
<tr>
<td>Assessment</td>
<td>Methods</td>
<td>Tests/interviews/observation/other</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Cognitive/behavioral/emotional</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1

*Literature selection criteria and process*

Results

Overall, the VR-based art appreciation education research showed an upward trend from
2000 to 2023. The number of articles published increased significantly in 2018 and 2021, with the largest number in 2021.

**Research Methodologies**

Regarding the research type, empirical studies accounted for 88% of the total (true-experimental 15%, quasi-experimental 35%, design-based 32%, and mixed 6%). Among these, quasi-experiments (35%) and design-based research (32%) were the top two frequently used methods to study VR-based art appreciation education. True-experimental studies (15%) and theoretical exploratory studies (12%) accounted for a relatively small number of studies. There were also a few mixed studies (6%) that used a combination of quantitative and qualitative approaches to assess learning outcomes, through questionnaires, interviews, observations, and audio and video recordings. The diversity of research approaches helped researchers to explore the mechanisms of how VR technologies promoted art appreciation education from multiple dimensions.

Regarding the duration and iteration of the studies reviewed, 70% of the studies conducted a VR experience. Of the studies, 67% only implemented the VR-based experiment once. The most common trial period was zero to one week (67%). This was followed by two to eight weeks (25%), studies of 1-2 weeks and more than eight weeks were the fewest (10%). The average study period was 8.3 weeks, excluding those where the study was conducted once. Overall, the study period and the VR experience time were both short in the studies of VR application to art appreciation. As Luo (2021) stated, VR as an emerging technology might trigger the novelty effect, its influence on student learning might change in the long-term application.

Among the 34 articles, 22 studies conducted sampling. The sample size was comparatively small in most studies, with an average sample size of 67, and a mode sample size of 6. The maximum sample size was 315, the minimum sample size was 6. Overall, 65% of studies were implemented with a small sample size that below 50.

**Instructional Design**

The research in formal learning contexts accounted for 65% of the studies, ranging from pre-school to higher education. Although art appreciation education in different grade levels focused on different learning objectives, for formal learning, VR was mostly used to cultivate learners’ knowledge, skills, and creativity in traditional classrooms (e.g., Wu, 2021). Some studies provided VR-based art appreciation education outside schools that targeted the general public despite age such as in museums and art galleries. Those cases were coded as informal learning (35%). In such contexts, VR was mostly used to enhance the attraction of exhibitions and optimize the interaction between exhibits and participants rather than the acquisition of knowledge and skills.

Regarding the instructional design, results showed that limited studies clearly explained their pedagogy and theoretical frameworks. Nevertheless, inquiry-based, collaborative, demonstration and embody were the four most used pedagogies for VR-based art appreciation education.
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(1) 71% of research reviewed designed inquiry-based learning activities, which usually consisted of an interactive virtual environment scene, structured inquiries, and a series of learning quests. For example, learners were guided to a virtual tour in a museum where they could take a tour and get information to answer questions and unlock more rooms, either autonomously or with the help of a guide (Longo et al., 2017). In Wu et al.’s (2021) study on art history learning, based on self-management strategies, learners were prompted to set goals and use VR to complete learning tasks and receive timely feedback. Inquiry-based learning in art appreciation education was also mostly armed with gamification or game-based learning strategies. For example, Zhang et al. (2018) used gamification learning theory to set up levels and rules so that learners could experience the virtual Terracotta Warriors site while applying the knowledge found in the archaeological research for cognitive construction in the game.

(2) The second popular pedagogy was embodying (68%). In such cases, VR technologies were used to present objects’ specific details and information so that learners could explore them independently and interact with objects to get a better experience, such as viewing artwork and related information in a virtual gallery (Cha et al., 2012). In the study by Han et al. (2020), researchers used VR technology to restore a virtual Dunhuang cave in a virtual scene, allowing learners to explore freely and adjust the viewpoint position and height, view the frescoes before and after restoration, and read the fresco stories. Sun (2010) found that learning sketching skills via VR did not differ significantly from traditional methods, but it allowed learners to observe objects more visually, and develop the perception and skills needed to construct sketches independently.

(3) In VR-based collaborative learning (12%), learning tasks or problems were done collaboratively by teachers and learners. For example, after experiencing VR independently, learners worked together as a group in a virtual environment and presented their work among the group (Pan, 2016). Another form was that group members took turns experiencing VR, learning and using the VR authoring software “CoSpaces Edu”, and subsequently, working together collaboratively to complete VR work (Kim et al., 2022). Notably, Paatela-Nieminen (2021) noted that if the VR experience took longer, students were encouraged to take turns or breaks after 30 minutes to prevent headaches or migraines.

(4) Demonstration (8%) is showing the VR avatar and demonstrating the movement for the learner, while the learner controls and views the avatar, imitating the movement and practicing the movement. For example, in Day et al.’s (2018) study, learners experienced the White Crane Dance scenario by wearing virtual reality glasses; they could walk freely to get different perspectives, and role-play to imitate and practice the White Crane Dance. In the study by Kusajima et al. (2018), the learner imitated the movements of characters in ukiyo-e paintings through head-mounted VR devices, and finally composed a complete painting to get a macro understanding of the composition of the whole picture.

Despite the variety of pedagogies used, all studies designed interactive VR-based activities to achieve learning objectives. With the development of VR technology, especially mobile viewers, learners had more autonomy in VR-based art appreciation education. Thus, there was a shift from instructor-centered to student-centered pedagogy such as independent exploration. Meanwhile, self-regulated strategy (Wu et al., 2021) was increasingly mentioned by researchers.
Meanwhile, although detailed theoretical bases were insufficiently discussed in studies regarding art appreciation education, constructivist learning mechanisms could still be inferred and interpreted from successful practices. Most studies emphasized knowledge construction and student-centered experience and attached great importance to interaction and feedback. Thus, scaffolding became increasingly important in VR-based learning. However, of the 34 articles, 67% studies used VR only once, and less than 20% of the studies trained learners in advance, meaning that most learners were given insufficient time to be familiar with the system before using it.

The majority of instructional methods were teacher-guided, technology-guided, and hybrid-guided during the learning process. The teacher-guided approach was the most common in formal classrooms. The teacher provided support to the learner during the learning process. The technology-guided approach included menus, icons, and arrows that appeared during use, which helped learners determine where and how to operate. Hybrid-guided approach involved both the teacher and the technology. For example, the teacher guided learners to set goals, monitored their performances with the help of a VR system, and then provided feedback to learners after they completed the learning tasks, and finally the system allowed learners to carry out self-evaluation (Wu et al. 2021). This suggested a need to design better scaffolding strategies to help learners use VR, and focus on the content while minimizing the cognitive load of technology manipulation.

**Technology Affordances**

In the VR Art Appreciation classroom, 84% of the studies utilized Helmet Mounted Display (HMD) for VR exploration and 8% use virtual desktops, which provided a more immersive experience for learners than virtual desktops. Eight percent of the studies used mobile devices (4%) as well as other devices (4%), such as projection and computer screens. Of these, 77% of the studies provided VR experiences in a fully immersive environment (i.e., entering the virtual world through a headset), and interacting in the virtual environment using handheld controllers. Twenty-three percent of the studies were conducted in semi-immersive environments (i.e., VR experiences and interactions on a computer desktop or other electronic screen).

When using VR for inquiry-based and embody, learners usually were allowed to roam in the built 3D virtual scene and involve in contextual interactions. For example, in Lin et al.’s (2020) study, the authors used 3D MAX to build a virtual gallery exhibition and then the UNITY software to integrate the scene and HMD; learners could roam the exhibition and view details and information about the paintings through the app. VR painting technology was also used in some courses regarding painting skills. For instance, in a lesson focusing on spatial ability, learners were provided with A-Painter (an open-source, web-based VR painting tool), 3D graphics via HMD, and two handheld controllers (Bolier et al., 2018).

Meanwhile, when using VR for demonstration, motion capture technology was mostly used. For example, Park et al. (2017) proposed a virtual figure model crafting system that allowed learners to directly experience the figure model crafting process using a head-mounted display-based. To implement the system functionality, developers leveraged motion grammar-based gestural input with Leap Motion. Similarly, to teach White Crane Dance and provide an immersive space environment for the viewer, Day et al. (2018) used HMD combined with Kinect.
motion capture sensor. Learners could watch 3D animation to learn the movement, and control their virtual body to dance along with the animation (Day et al., 2018).

**Assessment**

Fifty-eight percent of the studies assessed the effectiveness of virtual reality instruction. In the studies sampled, the most common assessment tool was a questionnaire, which accounted for 68% of the total. The qualitative analysis of learners’ artworks was the most rarely used (10%). In addition, behavioral observations, interviews, and video recordings were also widely used. Researchers evaluated the effectiveness of VR-based art appreciation education from multiple perspectives. In this review, the authors categorized the assessment focuses based on Fredricks et al.’s (2004) three dimensions of learner engagement: behavioral, cognitive, and emotional engagement. In addition, the author also proposed the fourth dimension focusing on the implementation and use of VR technologies and exploring learners’ mastery of VR operations.

In terms of behavioral engagement (35%), researchers focused on the extent to which learners interacted with VR and its immersion (Han et al., 2020). All studies that assessed the effectiveness of teaching have focused on cognitive engagement, researchers focused on the acquisition of art appreciation subject knowledge (Han et al., 2020), artistic skills (Som et al., 2021), and creativity (Kim et al., 2022). In addition, some researchers paid more attention to learners’ self-management and metacognition (Wu et al., 2021). In terms of emotional engagement (35%), researchers mostly assessed learners’ motivation and satisfaction after their virtual explorations (Hsiao et al., 2021), and in informal scenarios. Although existing studies varied in terms of learning objectives, 90% of the findings indicated that learners’ learning was enhanced after using VR technologies. In addition, drawing creation and creativity were important competencies in art disciplines, and the learning outcome was mostly assessed through learners’ artworks. Thus, as in Mills and Brown’s (2022) study, for example, a video recording feature was used to record learners’ creative processes during their 3D drawing using VR tools.

In general, VR art appreciation was assessed less for content and subject-related competencies and more for technical and emotional engagement. In informal learning environments, practitioners were more concerned with whether VR could enhance learners’ experiences and improve the attractiveness of the exhibition. Researchers designed programs or other computer software to record the process of VR-based learning such as the number of learners’ clicks (Han et al., 2020) and click areas (Mills & Brown, 2022). Some researchers also recorded screens to observe learner behavior (Wu et al., 2021), which was more accurate and detailed than traditional observation methods. Overall, 44% of the studies did not validate the teaching outcomes, and the lack of data support made it difficult to objectively evaluate the effect of VR in art appreciation teaching.

**Discussion**

As the learning objectives of art appreciation education varied in different learning stages, there was no unified paradigm for VR-based instructional design. However, it was found that many studies followed a constructivist approach, which emphasized agentic knowledge
construction and student-centered experience. Partly consistent with Luo et al. (2021), who found inquiry-based, collaborative, trial-and-error, and direct instruction were the four most used pedagogies in VR-based education, this research showed that for art appreciation education specifically, the mostly applied pedagogies included inquiry-based, collaborative, demonstration and embody. Meanwhile, VR-based art appreciation learning required a high level of autonomy for students to explore scenes, summarize and analyze the composition of artwork images (Kim et al., 2006), understand creative techniques (Hui et al., 2022), and gain aesthetic experiences. Also necessary was to provide students with the historical and cultural background behind the works and to help them better understand the relationship between art and culture.

Providing multiple interactive functions is central to the effective use of VR technology to achieve constructivist art appreciation learning. For example, some studies provided human-computer interactions through dialogue, exploration, and imitation (Kusajima et al., 2018; Zhang et al., 2018). Without interaction, helping learners achieve higher-level learning goals is difficult. In informal learning contexts, VR is mostly used to enhance the experience and attractiveness of the visit. Thus, embodying strategy aligns with such objective because art appreciation requires learners to observe and explore images or other artworks comprehensively. The immersion and presence that VR brings could not only make learners more engaged but also help them better observe artworks. Otherwise, designing a more interactive environment is needed for artwork appreciation if it is to achieve higher-level cognitive learning objectives.

Enlightened by the literature, this paper proposes three suggestions for the design and implementation of VR-based interventions. First, free-observation or the scaffolding should be built to restore authentic cultural and historical scenes. Most VR has been used to restore the original appearance of art works, presenting the whole work, specific details and related information (Zhang et al., 2023). To make learners’ observation more effective, VR should provide them with detailed and multi-directional perspectives. Also necessary is to enable learners to move and zoom freely, so that they can observe details as close as possible. In this way, learners are able to better grasp the details and modelling proportions of the work. If the scene is a virtual exhibition hall, the route should also be well-guided. Meanwhile, various prompts could be provided to help learner compare and classify different art works, which is an important objective of art appreciation education. Second, the balance should be ensured between free and structured exploration for the learners to experience the art-making process. Ideally, there should be multiple interactions between learners and VR resources that promote cognitive engagement. However, some VR only provided text or voice explanations, which were not sufficient to motivate students and promote cognitive engagement (Zhang et al., 2023). Similarly, if learners could only click objects to view more information (text, audio, video materials, etc.), it is difficult to enhance their critical thinking skills but only memorizing and understanding. Instead, when learners are able to really do something virtually, such as repair broken cultural relics, compose 3D animation, or imitate movements, their spatial ability, creativity and other higher level thinking skills could be improved. Finally, cognitive load of operating VR should be reduced through various scaffoldings. The cognitive load refers to the total amount of information that humans can process in the information processing process, mainly including the total amount of information stored and processed by working memory (Sweller, 2010). When using VR technologies for learning, some learners may not be proficient in the operation of VR. There is also evidence that high immersion sites lead to higher levels of affective processing, but “distracts
from needed cognitive processing during the lesson” (Parong & Mayer, 2021, p. 35). Thus, researchers need to strategically guide learners to use VR resources to reduce the cognitive load so that learners can focus on the learning content. For example, a demonstration of VR operation should include a manual of how to operate the technology to be helpful. Learners should also be given enough time to try out the specific VR tool.

**Conclusion**

This study systematically reviewed 34 research on virtual reality in the field of art appreciation, and provided references for future research in four aspects: research methodology, instructional design, technical affordances, and assessment. In general, increasing empirical studies demonstrated the effectiveness of using VR technologies to improve learning outcomes in art appreciation education. However, the experimental period of VR-based intervention was generally short, and the sample size was small. While the use of VR in formal learning contexts mostly followed a constructivist learning paradigm, theoretical frameworks in informal learning contexts were still limited. Using VR technologies benefitted learners’ cognitive engagement, behavioral engagement, and emotional engagement. But given that most studies took place in informal learning environments, future research on VR art appreciation might further systematically investigate its influence in formal learning contexts. Despite the learning contexts, interaction was central to the effectiveness of using VR to achieve these learning objectives. Moreover, this paper proposes three recommendations for the design and implementation of interactive VR resources to help practitioners better implement VR technologies in art appreciation education and improve the quality of learning.

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Reference


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