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Abstract

While images are central to the discipline of art history, surprisingly little research has been conducted on the uses of digital environments for teaching in the discipline. Over the past decade, more studies have emerged considering the egalitarian space that can be used by students and teachers in web-based applications and social media. A body of literature has begun to emerge out of a small network of scholars and educators interested in digital humanities and art history, providing examples of how new tools can be integrated into the standard slideshow and lecture format of the field. At the same time, the latest technology that proves revolutionary for the field has had very little study-virtual reality (VR). Additionally, sensory evidence for digital art history and the creation of immersive interactive and multimodal environments for knowledge production is still underexplored. As multiple educational metaverses are currently under development, understanding best practices and pedagogical use of VR has never been timelier. This study seeks to review the pedagogical use of VR in art history current in the field and introduces results from a study of the most effective ways to use these immersive experiences using Bloom's revised taxonomy. Results confirm that the most effective method to structure VR assignments is to provide training on the technology, provide students with the necessary instructional material to introduce the concept, skill or technique to be learned, create or select an immersive experience that reinforces that topic, and conclude with a debrief or discussion about major takeaways from the experience.

Keywords

Virtual Reality, XR, Learning Outcomes, Art History, Experiential Pedagogy

1. Introduction

While many studies, especially in the digital humanities, have sought to integrate

the latest technology and new media into the curriculum of art history, little has been published on the pedagogical application of virtual reality (VR) in particular [1]. For instance, in the collection of essays on Teaching Art History with New Technologies, new digital technologies and web-based applications for building concept maps and GIS are discussed, but VR was in its infancy [2]. Finch [3] confirms the surprising dearth of studies and points to the apparent hostility of digital environments in teaching in the discipline. A study by the Kress Foundation in 2011 confirms the assumption. The study was carried out with the Roy Rosenzweig Center for History and New Media at George Mason University and surveyed professionals on their use of digital art history [4]. The findings indicate an ambivalence or open hostility toward digital art history despite promising learning outcomes.

The most recent research into the use of VR in education has noted that the affordances include engaging learners in generative processing [5]. As with introducing a reading or a video, an immersive experience can either precede or follow a traditional lecture on a given topic in the field in order to provide greater insight or context [6]. Yet, little research has been undertaken to understand the pedagogical benefits of how instructors may leverage the immersive capabilities unique to the technology. Studies have thus far focused on qualities of presence, engagement, and immersion in general terms [7] [8] [9]. The manner and degree to which students are able to benefit from these qualities, however, depends upon their emotional engagement. Playing a video game or watching a video does seem engaging on their own, but in order to acquire emotional skills, technology employed needs to arouse emotional responses to support learning [10]. Certainly, cinema has the ability to evoke emotions in spectators, but does not induce emotions with a consistently high standard of reproducibility, prosocial change, and control [11]. Furthermore, there is the challenge of needing to induce emotions in an authentic way in order to simulate a user's real-life experience. Virtual reality is ideally suited to such experiences within virtual environments where stimuli can be controlled [12]. Once the experience has been identified and aligned with a learning outcome, positive results are noted and sense experience leveraged [13]. On the other hand, the relationship between the selected experience, outcome, and pedagogical methodology used in the classroom, especially the relationship between the use of VR and the instructional material, has yet to be thoroughly investigated.

The pedagogical approaches and methodologies best suited for the use of VR need be investigated. As such, this study seeks to determine the most effective pedagogical use of virtual reality using Bloom's revised taxonomy. Students from two sections of History of Western Art to 1300, which covers prehistory to the Renaissance, were instructed to complete the same virtual reality applications, which took them through a reconstruction of Pompeii. The first class had the experience before covering the material in class with a lecture and discussion. The second class had a lecture covering the material in class, and then had the VR experience without further debriefing. Student surveys, instructor feedback,

and artifacts produced following the experience confirmed that introducing a topic to students that is reinforced with a VR experience and other supplementary materials then meeting together and discussing the topic in class yielded the best results. Furthermore, students claimed that with the limited interaction of the selected experience, VR is best suited for the lower levels of Bloom's revised taxonomy: "Explain ideas or concepts" (understanding), "Draw connections among ideas" (analyzing), and "Help recall facts and basic concepts" (remembering). The study confirms that the use of virtual reality improved student engagement and outcomes, as well as better understanding of topics covered.

2. Literature Review

With the ability to effectively transport students to any site in the world, including world culture heritage locations and museums, immersive realities are ideally suited to understand the context of a work. Through conveying critical changes in time, space or behavior through interaction and sensory immersion, these games can create thematic conceptual experiences that are themselves framed by contextual meaning. The field has already adopted emerging technologies to investigate cultural artifacts. Taking cues from the artworld itself, art historians disseminate reproductions of works first through printmaking and then through projections with magic lanterns. The modern age saw the rise of the slide carousel projector and now the ubiquitous ceiling-mounted LCD projector in classrooms across the world today. Art history has always sought out the most immersive methods to bring works to students. Furthermore, the ability of these emerging technologies to preserve, represent, and disseminate cultural heritage has received much attention in digital humanities scholarship [14] [15] [16] [17] [18]. But unlike the earlier technologies listed above, VR is not primarily a passive information delivery system. VR and gaming have the unprecedented educational ability to dynamically engage students and educators in a simulacrum. The three characteristics that act in concert to provide such an experience are outlined by Bekele and Champion [19] as the ability to: "1) establish a contextual relationship between users, virtual content, and cultural context, 2) allow collaboration between users, and 3) enable engagement with the cultural context in the virtual environments and the virtual environment itself." The features afford users the ability to engage with the experience, other users, and a deeper understanding of the context of the relationship between the three in a virtual environment.

Studies on the use of virtual reality (VR) in the art history classroom follow the increase in availability of hardware and relevant applications. Early studies focused on elements of immersion, presence, engagement, and educational potential of the new technology. For instance, a project by Casu, Spano, Sorrentino and Scateni [20] sought to leverage the lower cost of consumer hardware in developing an application for the teaching of Art History. Art Thief is another example of a game created at the California Institute of the Arts (2017) for CalArts

Game Makers Club. In this scenario-RPG, a young security guard named Olive must fend off an art thief in a museum, while simultaneously interacting with the museum staff and visitors to solve puzzles, etc. Unfortunately, the 2D game is limited in its interactions and is not as engaging as immersive content to be discussed [21]. Other examples allow for ease of use in configuring museums as desired. For example, ArtRift, a VR tool designed for art history students and teachers, allows for the configuration of virtual rooms in a museum with pre-selected artworks and is enhanced by multimodal annotation. Improving upon a traditional art history lecture where two works are compared and contrasted, the application allows for works to be juxtaposed with each other in each room and instructors add additional multimedia content, such as audio or textual descriptions. Among the immediate benefits of such virtual spaces, outlined by Casu, Spano, Sorrentino, and Scateni [20], is that comparisons can be made in a physical space that would never be possible in reality. Large sculptures, such as Michelangelo's David and Moses cannot ever be seen together as one is in Florence while the other Rome. In these simulated, virtual museum spaces, students can now compare the physical and stylistic elements of art as they were unable to do previously. In order to study the effectiveness of the application, students at Filippo Figari High School, Sassari were broken into two groups. The first was given access to works through a LCD projector on a wall, while the second through VR. At the close of the class, students were given the Instructional Material Motivation Survey instrument (IMMS) to assess their experiences. Students were queried on three areas: Attention Factor, Satisfaction, Relevance. All areas had qualitatively significant reporting and motivation was improved through the use of VR as opposed to traditional instructional methods.

As the previous example illustrates, previous research in the use of VR has primarily focused on secondary education [22]. As an example, Brownridge [23] outlined a curriculum to integrate VR into history and social studies classes in K-12 education. In the examples provided, students would take virtual field trips using Google Expedition (GE). A series of studies confirmed improved engagement and motivation once VR was integrated into coursework. The few studies that have been carried out in postsecondary education, however, have found the same positive correlations. For instance, Ghida [24] discusses how immersive reality has been used in his History of Western Architecture class, leveraging the ability to study a three-dimensional monument fully in three dimensions instead of an image or digital projection on a two-dimensional surface. Ghida provided students with specific monuments to view in Google Earth VR (released 2017) in order to experience monuments virtually in human scale. Given the advantages for architecture students, there is little surprise that the approach has since been adopted in architecture departments around the world, including Utah State University, MIT, Queensland University of Technology, Georgia State University, University of South California, the Chinese University of Hong Kong, Mount Saint Mary College, NY, and Florida State University.

In addition to providing the ability to tour monuments in three dimensions, research has also demonstrated that, as in the sciences, VR can be used to understand abstract concepts such as chronology in the field of art history, as well. Through a study of UK and Ukranian students at three levels from secondary to college, Korallo [25] sought to determine the effectiveness of using VLEs to assist in the teaching and learning of historical chronology in different fields. The study confirmed the difficulty in teaching the abstract nature of time for different learning levels. In order to learn the sequences of events and address this pedagogical issue, the groups were taught the sequences of events in a virtual environment. At the same time, control groups were shown the same events with texts and pictures, as well as with PowerPoint slides. Sets of parallel timelines were shown simultaneously, including music and art history, and the history of psychology, art and general history, respectively. The most beneficial experience was when undergraduate students were able to view three parallel timelines simultaneously within a continuous virtual environment. More specifically, using virtual environments assists in understanding historical events on a timeline and is a superior learning strategy than traditional techniques.

Another immersive experience was developed for a Renaissance art history class at the University of Indiana, Bloomington. Brennan [26] supported by the subject-matter expert, Dr. Giles Knox, developed four fresco cycles in the Unity game engine. With limitations of the HTV Vive headsets needing to be connected to a desktop computer, there were not enough units nor space to set up in the actual classroom, and thus the Virtual Reality Lab on campus hosted small groups of students outside of class time. After covering the material in class, students would then set up a time to explore the fresco that had just been covered, starting with the Scrovegni Chapel in Padua, Italy. 360-degree photographs of the cycles were imported as skyboxes into the game engine to support the build out. As prolonged movements often lead to VR sickness, students moved through the experience via teleportation between skyboxes/nodes. Smart history lectures were triggered when approaching the respective scenes. The production phase was followed by play testing and several iterations of the application to ensure the best user experience. In the study, students had the experience after covering the material in class. No data was collected regarding outcomes and taxonomic considerations.

The previous examples, while important early research into the field, dealt with limited pedagogical study of the use of virtual reality for art history coursework. In fact, few studies on VR pedagogy have been conducted in any area. The few that have do indicate a beneficial structuring of course activities to maximize the impact IR have on student engagement and interaction. For instance, Thorsteinsson [27] noted that in the Innovative Education (IE) study in Icelandic schools, Virtual Reality Learning Environment technology (VRLE) was used to support innovation. The technology was used to support online communications and collaboration between students and teachers to develop drawn solutions and descriptions of solutions to problems. The study by Thorsteinsson outlined the

considerations for implementation and the various pedagogical spheres of learning that included the student's home, classroom, and VRLE environment. Students would generate content for the course for their homework, learn how to use the technology in the classroom, and ideate while using VR headsets and collaborate with other students. The steps set out for the curriculum included 1) finding needs; 2) brainstorming; 3) creating and choosing initial solutions; 4) concept drawing; 5) creating a description of the solution; and 6) presentation of solution. The sequence included introducing a concept/problem and training in the technology, then the use of VRLEs, and, finally, a debrief with a discussion and presentation. The steps paralleled those taken by the teacher over the course of instruction, which included 1) introduction; 2) basic training; 3) students reporting needs and problems; 4) brainstorming sessions with students; 5) students working in groups or as individuals to develop solutions inside of VRLEs; and 6) summarizing lessons for students.

While studies specific to the field of art history have focused on limited qualitative evidence, further investigation into when, how, and for what purpose VR should be leveraged in educational settings is necessary. For instance, given the limited availability of games, simulations, or experiences provided by applications between 2000 and 2015, studies naturally focused on the potential viability of the new technology as a tool to enhance learning. With the release of the Oculus Rift in 2012, HTV Vive in 2015, and Oculus Quest 2 in 2020, the barriers to adoption were largely removed. With greater access to the head-mounted displays (HMDs), educators and researchers could expand access to a wider demographic for a variety of studies. As studies now confirm, the positive correlation between the use of VR in education and learning outcomes and engagement, institutions of higher education are adopting the technology at greater rates. Recent polls also indicate that 90% of institutions will increase adoption of XR in the next five years, while only 12% are currently adopting XR broadly [28]. With educational metaverses in development, understanding the best practices and pedagogical strategies when implementing the technology has never been timelier.

3. Methodology

The mixed-methods study included data from surveys collected from students, instructor feedback and artifacts (short essays). The sample was collected from Lindenwood University, a private, four-year, liberal arts institution in the suburban ring of St. Louis, Missouri. Participants included 47 students from all four academic colleges from across the institution: Colleges of Education and Human Services, Arts and Humanities, Science, Health and Technology, and The Plaster College of Business and Entrepreneurship-enrolled in two General Education sections of History of Western Art to 1300. The two hybrid sections were offered in the Fall semester of 2021 and were designed to meet 50% of the allotted time face-to-face with additional activities, including readings, research, and recorded lectures, outside of class. The purpose of the project was to assess pedagogical

best practices for the use of virtual reality (VR) through student perceptions, performance, and feedback coupled with instructor feedback and observations.

Students were tasked to engage with the Pompeii Experience available on the Oculus Rift. Additional learning activities focused on the city of Pompeii included a one-hour documentary, a brief online article, as well as classroom and recorded lectures and discussions. All students submitted a reflection paper in conjunction with the assignment. The experience occurred at the midpoint of the semester in addition to other standard course assignments that included a traditional formal analysis paper and two exams with slide identifications and comparison essays. Students in section one of the course were instructed to complete the VR experience, documentary, article, and online lecture before attending class. Following the experience, factual information regarding life and civilization in Pompeii was discussed in class. Students in the second section were instructed to view the experience after the content on Pompeii was presented in a classroom lecture.

This project utilized a mixed-methods approach to gather data, including qualitative (open-ended comments) and thematic (quantitative) results from an online survey. The survey instrument focused on the different methods for imparting information, as well as four different forms of media and thus informed the pedagogical considerations of VR. The survey was administered in Fall of 2021. Data collected afterwards gauged student demographics, feedback on the VR experience, asked for student preference for the order of introducing an art historical subject and supplementary learning materials, and how the technology would best be utilized in the six categories of Bloom's revised taxonomy. Students were then asked an open-ended question regarding their experience and what they felt VR was pedagogically best suited to accomplish. Students were contacted either through the University course management system or were emailed with links to online surveys. The survey was available for approximately two weeks at the end of the eight-week term and all data was collected using Qualtrics to ensure privacy and anonymity of responses. These results were sorted based on demographics (such as gender identity, major, age, etc.) and data were exported from the survey system. Descriptive statistics were calculated and used for comparisons between groups. The comparison of the two sections looked carefully at the level of engagement, discussion participation, excitement over the topic covered, understanding of material, and this was gauged via data gathered via student surveys, reflection papers, and outcomes on assignments and exams. The reflective essays students produced were evaluated along with the results of the surveys in order to glean more information on learning outcomes and more extensive feedback on the experiences.

4. Results

Of the 47 student respondents, 97.87% of participants were between 18 - 24 years of age; 61.7% identified as female, 36.17% male, and 2.13% non-binary;

76.60% identified as White, 14.89% Black or African American, 6.38% Hispanic or Latino, and 2.13% Asian. The majority (59.57%) of students were enrolled in the course to fulfill a General Education requirement, 36.17% enrolled to fulfill major requirements, and 4.26% as an elective. While most of the students (83%) reported being slightly familiar or more with VR technology prior to the class, 68.09% of them had also never used VR previously, while 27.66% reported using it on a monthly basis, and 4.26% of students reported using VR weekly Figure 1.

In terms of student perception of their preference for completing the VR activity prior to or after discussing the history of Pompeii in class, students preferred the chronology employed in their section. Of the students in section one who completed the VR and associated Pompeii activities before the activity debrief and lecture in class, 50% reported that have a VR experience prior to learning about Pompeii in class was better, while 20% felt it would be better after learning about the city in class Figure 2. Likewise, 50% of students in section two who completed the VR activity after discussing the history of Pompeii preferred this chronology, but none thought it would be better to complete the VR activity before class. In a follow-up question regarding when they considered it would be appropriate to conduct a VR experience, each group also were inclined to their experience, where 90% of the students section one felt it would be somewhat to extremely appropriate to complete a VR activity before coming to class, 70% of the students in section two found it somewhat to extremely appropriate to learn about Pompeii in class before completing their VR activity Figure 3.

Student perception of preparation to complete a VR experience also did not differ strongly enough to inform the chronology of the assignment. All respondents from section one felt somewhat to very prepared to complete the VR activity

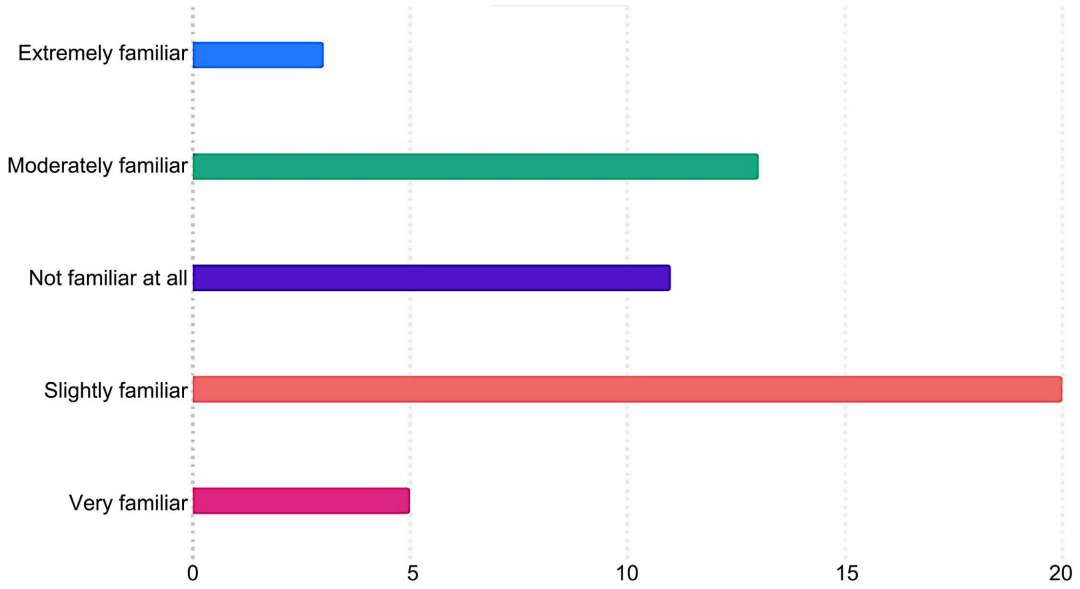

Figure 1. Student familiarity with virtual reality (VR) technology prior to class.

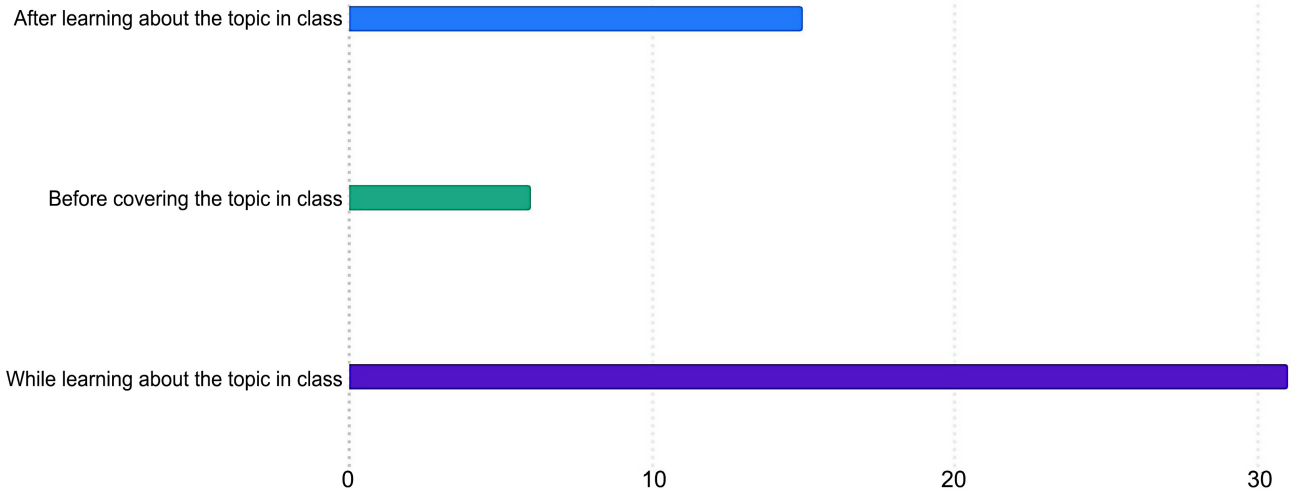

Figure 2. Student preferences for timing of VR experiences.

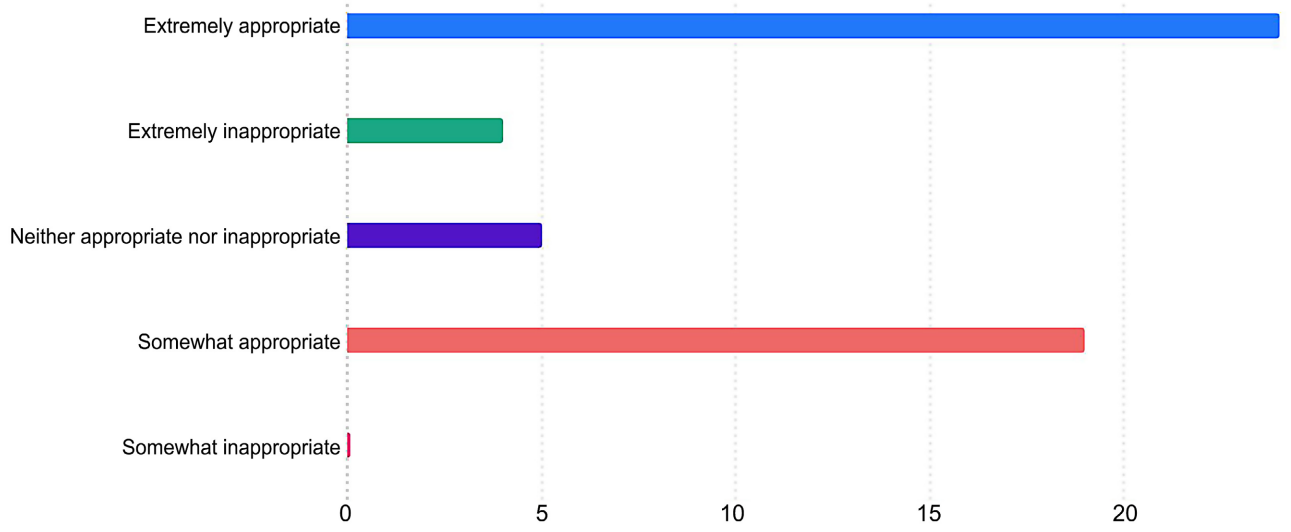

Figure 3. Student evaluation of appropriateness of timing of VR experiences.

before lecture. This rate actually decreased for section two, where 90% of students in this section felt somewhat to very prepared for the activity after learning about Pompeii. However, the students may have interpreted this sense of preparation to mean the instructions for how to complete the assignment, how to reserve the Oculus Rift headset, etc.

An area of consensus from students in both sections was their perception of the benefit of VR. 71.21% of students overall claimed that VR helped them learn better, with 25.53% selecting "maybe," for its helpfulness, and only 4.26% who responded "no". Beyond this, 91% of students found that learning about Pompeii through VR was more useful than reading about the topic, and 79.1% stated that it was more useful than watching a video. Therefore, students find VR the most useful, then watching a video, and, finally, reading about a topic. Several students use the open comment portion of their survey to leave comments such as: "It was super enjoyable especially because I've never learned like this! Some-

times I felt overwhelmed with what I needed to look at because there was so much, so I liked the VR experiences where it teleported yourself to different locations and explained the art in front of you."

Along these lines, students ranked the following categories adapted from Bloom's revised taxonomy. Based on the aggregate responses, respondents found the following to be the learning objectives best suited for VR (in order from most to least beneficial) Figure 4:

1) Explain ideas or concepts (understanding)
2) Draw connections among ideas (analyzing)
3) Help recall facts and basic concepts (remembering)
4) Use information in new situations (applying)
5) Justify a stand or decision (evaluating)
6) Producing a new/original work (creating)

From the instructor vantage point, changing the order of classroom lecture and student engagement with the Pompeii activities made a large impact on the shape of the class discussion. When introducing his students to Pompeii before they completed the additional assignments, Olsen reports that this order gives the instructor an open field to introduce students to the history and developments of Pompeii, with which they may not already be very familiar. Introducing new content in class can be an enjoyable component of teaching, especially when it is a topic that tends to pique student interest, such as the cataclysmic events at Pompeii. The clear disadvantage of this order is not being able to capitalize on the excitement students experienced engaging with the VR and additional learning materials. While they did record their observations in response papers, the level of enthusiasm wasn't transferred into the written response to the same degree as it was for students who discussed their experiences in class. And as the reflection paper was an individual assignment, it did not allow students to feed off of each other's experiences in discussing their observations. As a final positive element, when introducing new material to students before they

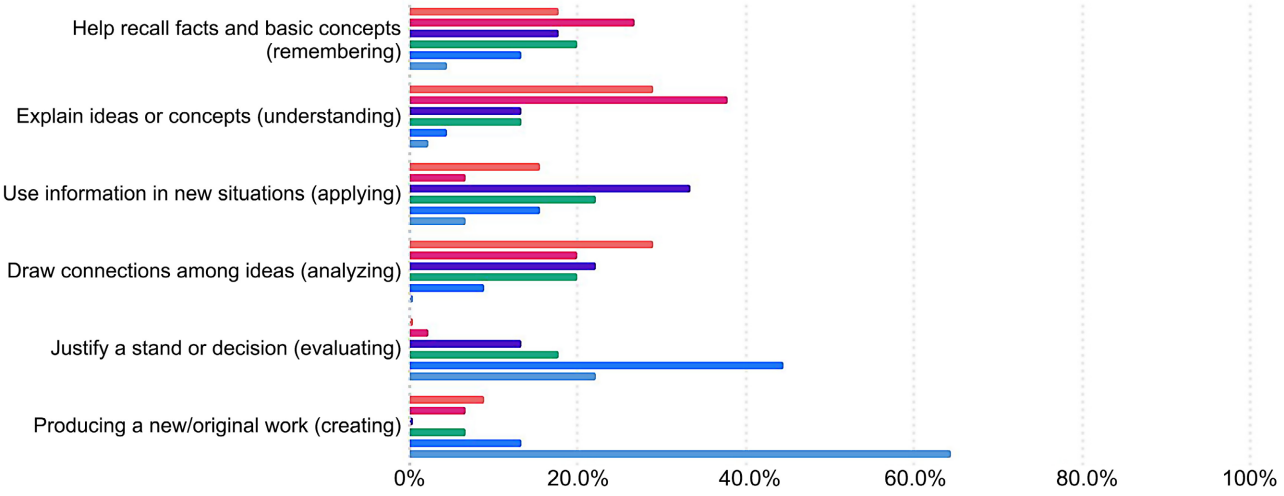

Figure 4. Student rank order of taxanomic benefits of VR experiences.

complete their activities as supplemental learning, one can verify that they have attained a level of proficiency and understanding. Completing additional materials after that will then provide even further clarification and insight to build on a base that they have already established.

In contrast, asking students to complete the VR assignment materials prior to discussing them in class carries much of the same benefits one encounters in instructing a flipped classroom. Students come to class with a solid level of understanding. But in this study, their experiential learning enhanced their understanding far greater than just engaging with a prerecorded lecture. Their understanding for the layout, remains, and daily operations of Pompeii was considerably more in-depth. That experience allowed classroom discussion to move beyond just quizzing or reviewing, and instead more time was used in analysis and application of learned concepts. What's more, students came to class excited to talk about their impressions. Olsen's sense is that part of this was due to the nature of discovering Pompeii and the charismatic and thought-provoking characteristic of the documentary his students watched. But these materials, in addition to the added layer of the novelty of VR technology and gaining a sense of experiential learning had a noticeable positive impact on his students. As students reported, the ability to see and move through the remains of Pompeii was exciting. However, they did report some minor frustrations with aspects with the VR application (glitchy movements, difficulty in navigation, VR sickness, less compatibility for students with glasses). One student articulated a clear point of benefit from this approach. He recounted his excitement when he had completed the VR experience before watching the documentary. When the video moved through an area of the city he had encountered in the application, he enthusiastically expressed "hey I know that area, I just 'walked' along that street!"

As reflected in the survey data, the majority of students expressed their preference for learning about Pompeii via VR over watching a video or reading an article. In class, several students iterated this preference, citing the imitation of corporeal engagement in the process of their learning as being a factor that was so appealing. They enjoyed the active nature of the application, that they could move through spaces in the city and view things of their choosing, which they stated was more generally more appealing than just viewing a video on a screen.

Recommendations

Students from each section expressed a preference for their own order of engagement with learning materials. What is clear, however, is that students from each section saw the use of VR as beneficial in their learning. The use of this application assisted in their learning, sufficiently targeting the areas of Bloom's taxonomy that involve "explaining ideas", "recalling facts", and "creating new connections" as the most beneficial aspect of this technology. Those that were prepared with the instructional material prior to the experience and had an active learning activity including a debriefing discussion thereafter performed bet-

ter on assessments. And while an instructor can utilize any order of engagement activities and classroom discussion to positive results, the instructor of record for this course found that debriefing the activity afterwards promoted more stimulating discussion and engagement in class. One possible explanation would be that when students arrive in class with a deeper, preliminary understanding of a topic, as well as a general enthusiasm regarding the experiential learning that has been encountered, and then the experience can be leveraged for further analysis and more in-depth application during in-class activities.

5. Conclusion

The adoption and use of VR in postsecondary education is still in their infancy. More educational applications are being developed across disciplines for ready-made experiences to introduce, reinforce, or master content. As with other pedagogical practices, instructors should use best practices to ensure the most benefit can be gained from the use of this and other emerging technologies. Merely selecting an application with similar content or subject matter to a topic covered in class will not guarantee a positive correlation between the experience and student learning outcomes. Understanding the benefits and limitations of virtual reality will be crucial in the coming decade for higher education, and the first step is familiarizing oneself as an educator with the tools now available for deployment. One should also consider how such tools should be used in the classroom. As demonstrated with this study, and confirmed in another [27], successful use of VR technology in the classroom should consider Bloom's revised taxonomy and introduce the concept and problem, train students on the use of the technology, allow them to experience it, and then debrief on their experience, as well as reinforcing learning outcomes.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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