

A virtual reality exploration of library services: Affordances and perceptions

Abstract

Community college libraries provide valuable resources and services to both students and local residents. However, these libraries are not used as much as they could be, partly because people can find them hard to access and are unaware of what they offer. This study used both qualitative and quantitative methods to measure how well people remembered information from a virtual reality (VR) library tour compared to a traditional public presentation about the library's offerings. The study found no statistical difference in user knowledge retention between the control and experimental groups. Additionally, VR participants described positive experiences of autonomy and immersiveness while using the interface, expressed desires for a wider range of actions during the tour, and at times reported motion sickness and discomfort using the VR interface. While such VR tours afford access to students and members of the public not able to physically travel to the library, VR tours should be utilized as augmentations, not replacements, for ways of sharing what libraries offer. Future research should specifically investigate gendered differences in user experiences.

Keywords: virtual reality, community college, open educational resources, library services.

Volume 9 Issue 3 - 2023

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Received: October 17, 2023 | **Published:** November 01, 2023

Introduction

Virtual reality (VR) is emerging as a powerful tool for educational applications, especially given its potential to provide immersive, interactive learning environments.¹⁻³ In the context of community colleges, where resources are often limited and the need for flexible, effective educational methods is high, the application of VR technologies can serve as a pivotal extension of computer-assisted learning.⁴⁻⁶ This is particularly true for faculty and librarian-led developments, such as open educational resources (OER). OERs are "teaching, learning, and research resources that reside in the public domain or have been released under an open license that permits their free use and re-purposing by others".⁷ By aligning VR experiences with curricular objectives, faculty members and instructional librarians—who closely guide and support community college students in both online and in-person learning settings—could create OER that not only engage students but also deepen their understanding of subjects that involve mastery of digital literacies and research.

Unlike traditional computer-assisted learning technologies, VR offers a multi-sensory, three-dimensional experience that can closely simulate real-world scenarios.^{3,8,9} This provides a more comprehensive and nuanced learning platform, allowing community college students to, for example, access and explore library services and resources relevant to their writing projects. This advancement has the potential to revolutionize how faculty and librarians approach OER developments, enabling the creation of more versatile and effective instructional materials that can adapt to the diverse needs and media preferences present in community college settings.

Empirically speaking, my experience as a writing faculty member at community colleges indicates that students infrequently utilize library services, either in-person or online. While existing research cites library anxiety as a contributing factor to low usage of academic reference services,¹⁰⁻¹³ students' hesitancy may also stem from limited awareness of the range and utility of available library services for facilitating course-related projects. Furthermore, students who reside far from campus or participate in online learning may be ambivalent

about visiting the library in-person. Consequently, the VR-based instructional unit, "Exploring Library Services," an OER co-created by a faculty member and an instructional librarian, could serve multiple purposes: (1) providing access to relevant content, (2) encouraging autonomous learning, and (3) offering an enticing alternative method for students to explore readily available library services.

To facilitate inclusive access to interactive content about library services and resources through VR, I sought to examine how an instructional unit-featuring a virtual reality tour (VRT) of the Markosian Library at Salt Lake Community College-might enhance learning outcomes when compared to traditional in-classroom librarian presentations. The study hypothesizes that student retention of information related to library services and resources will be significantly higher when delivered via VR than through in-person presentations. Additionally, the study aims to explore whether the VRT format fosters a sense of presence and agency among students using the instructional unit.

VR-based learning in community colleges

VR for learning and vocational training has grown in popularity within the last decade.^{14,15} Higher education institutions, including community colleges, are gradually understanding its affordances, exploring its incorporation into the curriculum, and measuring its impact on the student experience.¹⁶ For VR learning, immersion and interaction are two key concepts requiring our understanding of their benefits for community college students in virtual environments. Immersion—"an objective measure of the vividness offered by a system, and the extent to which the system is capable of shutting out the outside world"¹⁷ (p. 939)—is a feature of VR-based learning that in-person and online students could benefit from regardless of their immediate location. Additionally, interaction, as another prominent feature of VR-based learning that relates to the degree of freedom afforded to the learner to control both learning experience and fidelity,¹⁷ could positively influence students' learning in virtual spaces they otherwise may not have access to in real life. If adequately implemented in OER developments, these VR features could provide meaningful dividends for student engagement and learning.

To contextualize the relationship between VR and educational outcomes, Makransky *et al.*¹⁷ introduced the Cognitive Affective Model of Immersive Learning (CAMIL). This analytical framework suggests that media and methods shape VR-based learning environments. CAMIL postulates an interplay between these elements, facilitating either or both of two specific psychological affordances inherent in VR-based learning: presence and agency. Presence is generally conceptualized as a user's sensation of "being there"¹⁸ and links intrinsically to individual perception, which means that its intensity can differ from one person to another based on various factors, such as attentional capabilities. Conversely, agency is characterized by an individual's capacity to initiate and manipulate actions within a VR environment.¹⁹ The primary predictor of agency in these environments lies in the degree of control users maintain over their actions, as well as their ability to influence environmental parameters.²⁰

Makransky *et al.*¹⁷ posit that instructional strategies amplifying learning through presence and agency are likely to boost learning outcomes via immersive technology (p. 958). As community colleges continue to advance in this domain, understanding and leveraging the CAMIL framework could be pivotal for optimizing VR's potential to enhance student learning experiences.

Existing metrics can measure these affordances and explain their impact on student learning in virtual environments. Polito *et al.*²¹ developed the Sense of Agency Rating Scale (SOARS), a measure of the subjective experience of users' self-generated actions. Similarly, Lessiter *et al.*²² created the ITC-Sense of Presence Inventory (ITC-SOPI), a questionnaire focusing on the determinants of presence and current self-report measures that capture users' experiences with media. As in previous studies featuring these metrics, SOARS and ITC-SOPI can assist in determining the impact of presence and agency within the VR-based instructional unit "Exploring Library Services" with community college students.

Material and methods

The study

This study employed design research^{23,24} to test and measure the impact of the instructional unit "Exploring Library Services" on student retention of information related to library services and resources and the affordances of presence and agency in a virtual environment. Specifically, this study sheds light on the implementation phase of a co-created instructional unit for community college students enrolled in the course English 1010 "Introduction to Writing" at Salt Lake Community College (SLCC) in Utah. The instructional unit curriculum, co-created between the researcher and an instructional librarian, aims to provide an overview of library services and resources available both in-person and online across various SLCC libraries. Two research questions (RQs) guided the study:

- RQ1: Is there a significant difference in student retention of information between traditional librarian presentations and the VR-based instructional unit regarding library services and resources?
- RQ2: What are the students' perceptions of the VR-based instructional unit in terms of the affordances of presence and agency?

Participants and settings

One week into the Spring 2022 school year, I invited four other faculty members in the English, Linguistics, and Writing Studies Department (ELWS) at SLCC, who also teach English 1010, to

allow their students to participate in the study. After receiving faculty approval, I emailed detailed instructions, including informed consent information, for faculty to announce this study opportunity during in-person class and via Canvas, SLCC's institutional learning management system. The eleven sections of students enrolled in English 1010 across three SLCC campuses (Redwood, South, and West Jordan) were invited to participate in the study voluntarily and were provided informed consent for their participation.

Using convenience sampling (see Table 1), a total of 129 student participants, primarily first-years, averaging 22 (17-61 years old), and self-identifying as female (n=55), male (n=70) and non-binary (n=4), were assigned into two groups: a control group (n=48) attending in-class librarian presentations based on the researcher's pre-established curriculum and delivered by an SLCC librarian, and an experimental group (n=81) that user-tested the researcher's pre-established curriculum of the instructional unit via VR.

Table 1 Class section distribution

	Redwood Campus	South Campus	West Jordan Campus
Control	2	1	1
Experimental	3	2	2

Instructional unit's curriculum and implementation

The instructional unit "Exploring Library Services" is organized into 13 physical locations at the Markosian Library building located at SLCC Redwood campus in Taylorsville, Utah. At each location, content offers (1) a detailed description of library services and resources available to SLCC students, faculty, staff, and community members and (2) comprehension questions to support and test student understanding. Below is a sample location description and comprehension question in the instructional unit's curriculum.

Reference desk front view

eBooks

Besides our print books collection, we have multiple eBook databases with hundreds of thousands of titles. You can access library eBooks 24/7 and from any place you have an Internet connection. Additionally, you can download some eBooks to read offline.

Q. eBooks can become available to you:

1. On your personal devices when downloaded
2. When in the library only
3. On the Internet
4. All of the above
5. A and C only

"Exploring Library Services" provided curriculum materials in two versions for implementation: a slideshow and a VRT. The materials for in-class presentations were provided to librarians two weeks before their implementation, while user and password credentials for VR testing, along with cardboard goggles, were provided to participants in the experimental group on the day of implementation in the classroom. These participants were encouraged to bring their own mobile devices (e.g., a smartphone or tablet) and earphones to be able to test the VRT. They also were required to download and run the CenarioVR app, where the VR-based instructional unit was created for implementation.

The librarian presentation involved content specific to library services and resources, delivered via a lecture presentation using slides. In contrast, the VR-based instructional unit provided a self-paced VRT of the same content but in an immersive environment.

While “Exploring Library Services” is intended for a general student audience, it was designed for students enrolled in composition-focused courses with an inquiry-based orientation (e.g., English 1010). In these courses, research is an essential component of the methodology, and the development of digital literacy skills is central to the learning objectives. Therefore, this VR-based instructional unit can serve as an innovative tool to supplement and enrich the educational experience in such contexts, potentially paving the way for more effective and tailored learning solutions.

Data collection

To answer the study’s research questions comprehensively, quantitative and qualitative data were collected using four types of data collection.

Pre-posttest: I created an 11-item knowledge test about library services and resources, including five student background information questions at the beginning of the test. Questions were mainly multiple-choice, formulated from the instructional unit’s curriculum, and underwent two revision rounds with two other ELWS faculty members who provided feedback for improvement. An informed consent letter for participant agreement was attached to the pre-test before the student background information questions.

ITC-sense of presence inventory (ITC-SOPI): This questionnaire consists of two parts. Part A contains six 5-point Likert scale items, ranging from “strongly agree” to “strongly disagree,” asking participants about their thoughts and feelings once the VRT experience is over. Similarly, Part B presents thirty-eight 5-point Likert scale items about participants’ impressions during the VRT concerning the affordance of presence. The ITC-SOPI evaluates presence in four dimensions: (1) spatial presence, gauging the participant’s sensation of being in a virtual setting, (2) engagement, determining the participant’s level of involvement in the virtual space, (3) ecological validity, assessing the virtual environment’s credibility and realism, and (4) negative effects, capturing any adverse psychological or physiological reactions to the VR technology.²² Each factor’s scores are analyzed separately in this metric. Parts A and B were preceded by sixteen student background questions about their demographics and experience with media.

Sense of agency rating scale (SOARS): This 10-item survey, using a 7-point Likert scale ranging from “strongly agree” to “strongly disagree,” inquires about participants’ thoughts and feelings during the VRT concerning the affordance of agency. Agency encompasses two components: (1) involuntariness, the perceived decrease in control over one’s actions, and (2) effortlessness, the perceived ease with which actions occur.²¹ Scores from each factor are combined to provide a total score for subjective agency.

Post-implementation follow-up questionnaire: I created four open-ended questions asking participants to describe their experience with the VRT of the Markosian Library. These open-ended questions provided an opportunity for participants to elaborate on their perceived sense of presence and agency post-implementation. Similar to the pre-posttest, these questions underwent two revision rounds with two other ELWS faculty members who provided feedback for improvement.

Data collected were distributed to participants via two Google Forms links that each faculty disseminated through Canvas with their students. Participants completed the online forms on their mobile devices during class time. I proctored the form completion in the classroom at two separate times (weeks 3 and 4 of the Spring 2022 semester), including breaks in between form-completion sessions for participants to relax and refocus. For the breaks, I provided several types of crunchy snacks, including gluten-free, vegan, and sugar-free options. Table 2 shows the forms’ distribution schedule.

Table 2 Forms’ distribution schedule

	Week 3		Week 4		
	Pre-test	ITC-SOPI	SOARS	Follow-Up	Posttest
Control	✓				✓
Experimental	✓	✓	✓	✓	✓

Data analysis

Quantitative data were analyzed using R and Excel. Calculations in R included an Analysis of Covariance (ANCOVA) to control for pre-existing differences among participants and to isolate the effects of the instructional approaches on learning retention. By employing ANCOVA, I could more accurately determine whether the observed variances in learning outcomes are directly attributable to the instructional methods (traditional librarian presentations versus VR instructional unit) or influenced by other covariates. Additionally, I used Excel to calculate the means of factors in the ITC-SOPI and SOARS to gauge the sense of presence and agency, respectively. Descriptive and inferential statistics from this analysis are showcased in several tables.

On the other hand, qualitative data were first transcribed into Word and then coded following thematic analysis.²⁵ This method allowed me to identify emerging patterns and themes relevant to understanding how presence and agency are perceived from the participants’ standpoint. The thematic analysis table below resulted from this process.

Results

Comparative analysis of traditional and VR instructional methods on learning retention

The Analysis of Covariance (ANCOVA) was employed to assess the effects of two different instructional methods—traditional librarian presentations and a VR-based instructional unit—on students’ learning retention while controlling for pre-existing differences among participants. The use of ANCOVA allowed for a more precise understanding of whether the observed variances in learning outcomes were genuinely due to the instructional methods used or whether they could be attributed to other covariates, such as prior knowledge or experience.

Based on this sample and the covariates controlled for, the VR-based instructional unit did not have a statistically significant advantage over traditional librarian presentations in terms of learning retention ($p = 0.2567$). This supports the usability of this approach for students otherwise unable to access library services in-person.

Further analysis of the mean scores from the experimental and control groups also supports this finding. The mean score for the experimental group, which utilized the VR-based instructional unit, was 45.83. In contrast, the mean score for the control group, which experienced traditional librarian presentations, was slightly lower at

45.40. The difference between the two mean scores was only 0.43, a minimal difference that seems unlikely to represent a meaningful educational outcome, especially when considered in conjunction with the ANCOVA's p-value. Overall, based on these analyses, both instructional methods are comparably effective in terms of learning retention.

Gender differences in virtual reality: ITC-SOPI and SOARS factor analysis

The data corresponding to the calculation of each factor's mean within the ITC-Sense of Presence Inventory (ITC-SOPI) and the Sense of Agency Rating Scale (SOARS) are presented in Table 4. The ITC-SOPI was used to evaluate the participants' sense of presence in four dimensions: spatial presence, engagement, ecological validity, and adverse effects. Meanwhile, the SOARS evaluated the sense of agency through two components: involuntariness and effortlessness. The scores from each factor were analyzed separately for ITC-SOPI and combined for SOARS to provide a total score for subjective agency.

For the ITC-SOPI, female participants scored higher in ecological validity (3.71) compared to male (3.31) and non-binary participants (3.9), indicating a greater sense of the virtual environment's realism and credibility among female participants. The engagement level was also slightly higher among female participants (3.43) compared to male (3.1) and non-binary participants (3.23). However, in terms of negative effects or adverse reactions to VR technology, non-binary individuals recorded the highest mean score (3.75) compared to female (2.92) and male participants (2.87).

In the case of SOARS, which evaluated agency, the mean score for female participants was slightly higher (4.29) compared to male (4.21) and non-binary participants (3.85). This suggests that female participants in the study felt a marginally greater sense of control and ease of action within the VR environment than the other groups did.

When we look at the total mean scores across all participants, ecological validity scored the highest (3.5) among the ITC-SOPI factors, suggesting that participants generally found the virtual environment to be believable and realistic. Agency scored the highest overall, with a mean of 4.24, indicating that participants generally felt a strong sense of control and ease while interacting with the virtual environment. These findings could have implications for how different demographics experience and engage with virtual educational tools and settings.

Presence and agency in exploring library services

In the context of this study, presence describes the user's feeling of immersion in the virtual world, while agency denotes their ability to interact within that environment. To understand these concepts, the responses of eighty-one participants who tested the VR-based instructional unit "Exploring Library Services" are presented in Table 3, highlighting the percentages of positive, negative, and mixed feedback. This feedback, obtained from four main questions, evaluates participants' perceptions of the Markosian Library's VRT, including its comparison to real-world experiences and their sense of control. Detailed responses from male, female, and non-binary students are presented in subsequent paragraphs.

Table 3 Thematic analysis table

Question 1:Abc			
No. Respondents: #			
Positive opinion: #	Mixed opinion: #	Negative opinion: #	Non-response: #
Male: #	Male: #	Male: #	Male: #
Female: #	Female: #	Female: #	Female: #
Non-binary: #	Non-binary: #	Non-binary: #	Non-binary: #
Sample quotes:Abc	Samples quotes:Abc	Samples quotes:Abc	

Table 4 Mean scores for ITC-SOPI and SOARS

Factors	ITC-SOPI			SOARS
	Spatial Presence	Engagement	Ecological Validity	Agency
Female (n=43)	3.2	3.43	3.71	4.29
Male (n=50)	2.78	3.1	3.31	4.21
Non-binary (n=2)	2.82	3.23	3.9	3.85
Total	2.97	3.26	3.5	4.24

Table 5 Responses to the post-implementation follow-up questionnaire

Question	Response Type	Male	Female	Non-Binary	Total	Percentage
Suggestions acceptance (Q1)	Positive	29	28	1	58	71.6%
	Negative	6	5	-	11	13.6%
	Mixed	8	4	-	12	14.8%
Virtual vs. real actions (Q2)	Positive	14	12	1	27	33.3%
	Negative	23	16	-	39	48.1%
	Mixed	6	9	-	15	18.5%
Experience of the VRT (Q3)	Positive	34	26	1	61	75.3%
	Negative	4	5	-	9	11.1%
	Mixed	7	6	-	13	16.0%
Sense of control (Q4)	Positive	32	27	1	60	74.1%
	Negative	4	2	-	6	7.4%
	Mixed	7	8	-	15	18.5%

Presence in the virtual environment

In exploring the role of presence in the VR-based instructional unit, participant responses were analyzed from two questions that probed their sense of “being there” (Question 3) and their overall VRT experience (Question 2).

When participants were asked about the likeness or difference of performing actions in the VRT compared to their everyday experiences (Question 3), the feedback varied. Positive responses across all genders emphasized the ease of the VR experience. A male participant noted, “It felt as real as in-person,” while another stated, “It was like someone telling me this information instead of having to read about it.” These remarks suggest that the VR environment could feel immersive and almost equivalent to real-life experiences to participants.

However, a majority of participants had a contrary view. They identified clear differences between the VR experience and real-life interactions. A female respondent expressed that the VR experience was more “robotic.” At the same time, a male participant pointed out that “the biggest difference in performing actions in VR than reality is the lack of movement. In VR, there is no real physical movement; instead, it felt like I was being teleported to each location within the library.”

Mixed feedback came from a smaller number of male and female participants. Their responses hinted at a blend of familiarity and alienation. One male participant said, “It was quite different. I would say it seemed 60-70% real to me,” while a female user stated, “It was similar in visualization to me because I have been there before. Different in the way, that when I would lean forward and backwards, my ‘head’ would stay in a stationary zone which made me dizzy.”

When prompted to discuss their feelings on taking a VRT of the Markosian Library (Question 2), a majority across all genders had a positive experience. They found the VRT interesting, informative, and fun. A male participant said, “It felt great! I enjoyed being able to do it within a couple of minutes and get facts instead of having to go to the library physically”. However, a subset of male and female participants found the experience less than ideal, with some feeling dizzy or disoriented. On the other hand, some participants had mixed reactions. One participant summarized, “I think it is a really cool concept, I just get motion sick very easily and had to move to the hand-held version.”

Agency in the virtual environment

Participants’ sense of agency within the VR experience was evaluated through two specific questions, focusing on their responsiveness to suggestions and their feeling of control throughout the VRT.

When asked about their experience following suggestions in the VR environment (Question 1), the majority expressed positive sentiments. Participants across all gender identities found the VR suggestions straightforward, clear, and instrumental in enhancing their navigation. “It felt very natural, and I liked how the icon moved around with me wherever I was looking,” shared a male participant, emphasizing the intuitive nature of the interaction. The integration of auditory and visual cues was particularly well-received, contributing significantly to the overall positive virtual experience.

However, there were points of contention, primarily among male participants, regarding technical aspects. Issues of excessive volume and visual clarity in the VR headsets were prevalent. “Reading

was tough when I had the VR headset on because the picture was slightly blurry, which is to be expected with VR headsets,” another male participant reported, highlighting areas necessitating technical refinement.

The mixed responses acknowledged certain positive aspects while offering insights for enhancements. Participants desired more autonomy, particularly regarding the pacing of the experience. “Good. The audio was a bit slow, and I would have liked the chance to skip it,” one female participant remarked, suggesting the need for more user control over the experience. Others noted physical discomfort due to VR motion, indicating a need for customizable settings to accommodate individual preferences.

The second question central to understanding agency asked participants about their sense of control during the VRT (Question 4). Here, the feedback was overwhelmingly positive. Participants felt a strong sense of autonomy, which enriched their engagement with the content. “I felt totally in control. I was the one making the choices on which prompts I wanted to listen to, what questions I wanted to answer, and where I wanted to go next,” a female participant recounted, highlighting the agency’s positive impact on the virtual experience.

Yet, not all participants shared this sentiment of empowerment. A subset, predominantly males, felt their experience was more prescribed than they preferred. “I felt like there was just enough stuff to do. And since it is just a library you can’t make it much more interesting,” a male participant expressed, indicating a desire for a more dynamic, user-driven experience.

Mixed feedback illustrated a nuanced view, where participants acknowledged some level of agency but sought improvements in certain areas. For instance, there was a desire for more exploratory freedom and control over informational segments. “I was in complete control, wish there was a way to skip a heard-on part when information was being presented,” another male participant commented. This desire for enhanced interactivity and user-defined exploration underscores the importance of agency in shaping a fully immersive VR experience.

Discussion

Comparative effectiveness of VR and traditional instructional methods on learning retention in community colleges

The results of this study are crucial as they challenge the expectation that technological advancements in instructional methods, such as the use of VR, automatically translate to increased learning retention.^{26,27} Despite the immersive and interactive nature of VR, the study did not find a statistically significant difference between the VR instructional unit and traditional in-person librarian presentations in a community college setting. This suggests that the effectiveness of instructional methods may be more complex and nuanced than just the medium of delivery, potentially influenced by factors like the quality of content, the context in which information is presented, and individual learning preferences.

However, these findings do not diminish the value of VR in educational settings. Instead, they highlight the importance of thoughtful integration of technology in education.^{17,28} The idea of a hybrid approach, blending VR with traditional teaching methods, emerges as a promising avenue. While this study did not find VR to be categorically superior (or inferior) in terms of retention, the immersive

nature of VR might significantly amplify student engagement and access when paired with conventional teaching methods, potentially leading to enhanced overall learning experiences. VR's strengths may lie in areas not fully captured by this study, such as increasing engagement, improving spatial understanding, or providing unique experiences not replicable in a traditional classroom.^{3,29,30} For instance, VR might allow students to take a virtual "field trip" to libraries around the world or to explore a 3D model of a library's resources and organizational systems. These unique applications could foster a more profound understanding or appreciation of the subject matter, even if they don't directly contribute to higher retention scores. Experientially, a virtual tour differs from listening to a presentation; this can be an important difference apart from knowledge retention as well (especially in terms of remote access).

In terms of practical applications for community colleges, these findings suggest that institutions need not feel pressured to allocate substantial resources toward VR technology solely for the sake of improved learning retention, as traditional methods can be just as effective. However, the potential other benefits of VR, such as student access, engagement, and satisfaction,^{1,16,31} are worth exploring further. Additionally, the study underscores the importance of focusing on the quality of instructional content, regardless of the delivery method.

Moreover, the study provides a framework for further research, bearing in mind that its findings are specific to a community college setting. This specificity makes generalizing to other educational contexts or different demographic groups a challenge. Therefore, further research is essential to determine if the results remain consistent across diverse educational settings or with varied demographics. Future studies might also explore whether the results hold across different subjects, the long-term retention of information, or if combining VR with traditional methods could offer a superior educational outcome. Additionally, given the rapid advancements in VR technology, the effectiveness of VR in educational settings should be an area of ongoing research. As technology improves and becomes more accessible, its potential impact on various aspects of education, including learning retention, may evolve.

Gender differences in presence and agency within VR learning environments in community colleges

The study explored the dynamics of gender and its association with experiencing VR, specifically in terms of presence and agency within a VR-based instructional unit. Using the ITC-Sense of Presence Inventory (ITC-SOPI) and the Sense of Agency Rating Scale (SOARS) as metrics, distinct patterns in participant responses emerged.

From the ITC-SOPI results, female participants exhibited a heightened sense of the virtual environment's ecological validity and engagement as compared to their male and non-binary counterparts. This suggests that female participants found the VR experience more believable and engaging. However, the adverse effects associated with VR technology were highest amongst non-binary individuals, suggesting a higher susceptibility to discomfort or disorientation within this demographic.

On the other hand, using SOARS for gauging agency revealed that female participants also experienced a slightly more pronounced feeling of control within the VR environment. This sense of agency is essential, as it denotes a user's ease and independence when navigating and interacting in virtual environments.

Feedback on presence and the feeling of "being there" offered a more complex picture. While some participants across all genders remarked on the virtual environment's realism, others felt the VR experience lacked the nuance of real-life interactions. Such mixed reviews were evident in responses that mentioned the VR experience being both familiar and foreign.

Agency, as examined through participant feedback, mostly portrayed a positive picture. A majority felt the VR environment was intuitive and responsive, fostering a sense of control. However, some technical hiccups, like clarity and volume issues, need addressing, as they have the potential to dampen the overall sense of agency.

For faculty and librarians, these insights offer a roadmap for enhancing the development and deployment of VR-based educational tools. By understanding the varied experiences and needs of different genders, educators can work to create a more inclusive and comfortable learning environment.^{32,33} The feedback provides cues to refine the technical aspects of VR tools, ensuring they are immersive without being disorienting.

Considering these findings, faculty and librarians looking to harness VR technologies in educational settings should:

- **Acknowledge Demographic Differences:** Recognizing that female, male, and non-binary participants might experience VR differently is crucial. Customizable settings and experiences might be essential to cater to diverse needs.
- **Emphasize Ecological Validity:** Since participants found the VR environment believable and realistic, further work should enhance this aspect, ensuring that students feel genuinely immersed.
- **Enhance Agency:** Given the strong sentiments of control and autonomy, VR modules should be designed to offer participants a genuine sense of agency. This could be achieved by incorporating more interactive elements or allowing users to control the pace of their experience.
- **Address Technical Limitations:** Feedback revealed some technical challenges, such as blurry visuals and motion discomfort. Addressing these issues will ensure that the VR experience is more comfortable and accessible for all.

Furthermore, the participants' feedback about desiring more autonomy underscores the importance of developing digital literacy materials and open educational resources that are not only informative but also resonate with a diverse student body. This will empower community college students to navigate better, interact with, and derive value from the virtual world.¹⁶ Ensuring that VR applications incorporate these findings can lead to a more enriching, dynamic, and holistic virtual learning experience.

Conclusion

The research provides important insights into the comparative effectiveness of VR and traditional instructional methods on learning retention within community colleges. Contrary to expectations, VR did not outpace traditional teaching methods in terms of learning retention. However, these findings highlight a broader narrative—that while the medium of instruction is essential, other factors, such as content quality and individual learning preferences, can equally, if not more critically, influence educational outcomes. If applied to a more diverse or larger sample size, there is the possibility that the study's conclusions could vary. Introducing a broader sample could present additional variables and nuances, which may affect the

perceived effectiveness of both VR and traditional teaching methods. Additionally, gender-related differences in the experience of VR environments underscore the need to understand diverse student populations better and tailor educational experiences accordingly.

Implications

The study's results offer several implications for educators, faculty, and librarians. First and foremost, institutions should not feel compelled to invest in VR solely for the promise of improved learning retention. Traditional methods continue to be effective, and the decision to integrate VR should be grounded in broader educational objectives, including student engagement, access, and unique experiential opportunities. Moreover, gender dynamics may play an important role in how different student populations experience VR, with implications for inclusivity and tailored content delivery. The need for educators to address technical limitations, as highlighted by participant feedback, can make VR experiences more accessible and user-friendly. Ensuring that VR tools are refined based on these findings can pave the way for a more inclusive and effective virtual learning environment and experience.

Future research

While the present study offers valuable insights, it also lays the groundwork for further investigation. Future research could delve into whether these findings are consistent across different subjects or academic disciplines. Additionally, exploring the long-term retention of information taught through VR versus traditional methods could provide a more comprehensive understanding of the medium's effectiveness. Combining VR with traditional methods might yield an instructional method that leverages the strengths of both. As VR technology continues to evolve, its potential impact on various aspects of education needs continual assessment, keeping the study's findings in perspective and examining new advancements in the context of educational efficacy.

Acknowledgments

None

Conflicts of interest

The author declares no conflicts of interest.

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