Virtual Studio 1.0: A Virtual Tacit-forward Learning Management Framework

Travis Flohr[1], Ken Tamminga[2], Tim Johnson[2]

[1]Penn State University, Pennsylvania/USA · tlf159@psu.edu
[2]Penn State University, Pennsylvania/USA

Abstract: The purpose of this paper is three-fold. First, it documents the creation of a Virtual Studio learning management system that supports formal and informal tacit learning. Second, it provides a faculty reflection, and third, it presents student perceptions of the Virtual Studio in supporting an online planting methods course during COVID-19 restrictions. Survey results demonstrated strong support for using the Virtual Studio. However, students do not perceive it as a replacement of in-person instruction. Future Virtual Studios should explore the inclusion of real-time verbal communication to deepen social- and co-presence.

Keywords: Tacit learning, virtual studio, learning management system, studio presence

1 Introduction

This paper describes the creation and student perceptions of a Virtual Studio learning management system (LMS) that supports formal and informal tacit learning. The virtual studio LMS supports all the standard functions of a traditional LMS – course administration, documentation, tracking, reporting, automation, and delivery. The virtual studio LMS differs from a conventional LMS in two ways: facilitating presence and live desk critiques. The purpose of this paper is threefold. First, to document the technologies used to model and host the Virtual Studio, including the underlying instructional support technologies. Second, to provide faculty reflection on, and evaluation of, the process and workflow, and assess to what degree it supported student engagement. Third, to document student perceptions and experiences of learning within the Virtual Studio environment. The length of this paper and the structure of the research design does not allow for an in-depth discussion of virtual versus non-virtual learning management systems. Instead, we focus on developing a virtual tacit-forward learning framework and students' perceptions of a pilot Virtual Studio LMS.

Studio. The word alone has a deep meaning within the design professions. Studio is a place where students research, propose, develop, interrogate, present, and reflect on design propositions that synthesize material from a diverse range of sources, both inside and outside the curriculum. However, in online education, design students lose some of the formal and informal tacit learning opportunities typically afforded by their physical studio environment. Indeed, the switch to online modes of learning halfway through the 2020 spring semester due to COVID-19 did not always effectively facilitate interaction in our tight-knit studio groups – what WENGER (1999) refers to as 'communities of practice.' Specifically, Zoom and Canvas at best only moderately supported peer-to-peer and engaged approaches discussed by SHALINSKY and NORRIS (1986) and BROOKS et al. (2002). Similar challenges were met by most other online studios in our graduate and undergraduate programs. With that hindsight, we critically discuss constructing a virtual tacit learning management system for our Fall 2020 studio.

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1.1 Planting Methods (Course Background)

The Virtual Studio supports the 2020 Fall Planting Methods (LArch 335/837). LArch 335/837 is a three-credit, technical implementation course within the Department of Landscape Architecture at Penn State University. The course enrolls 41 3rd year undergraduate bachelor of landscape architecture (BLA) and three 2nd year master of landscape architecture (MLA) graduate students. LArch 335/837 meets six-hours per week and runs for 15 weeks. Both the BLA and MLA are accredited professional degrees prerequisite to the licensure needed to practice in most U.S. states and Canadian provinces.

1.2 Course Goals and Pedagogical Foundation

The authors leverage both explicit and tacit learning theory because the primary goal of Planting Methods is to facilitate learning about plants and planting implementation in the designed landscape. Objectives promoting this goal were to i) gain experience in the horticulture and "ecoculture" of contemporary planting genres ii) develop technical abilities in specie selection, planting establishment, soil improvement methods, plant installation details, and adaptive management of planted landscapes iii) gain fluency in contract documentation iv) bolster progressive planting design theory that addresses aesthetic, ecological, and functional factors, and v) continue the development of digital design software (e. g., AutoCAD, SketchUp, Adobe Creative Suite, and Lumion) for conceptualization, visualization, and contract documentation. The course aims are accomplished through scaffolded learning (WOOD et al. 1976) through three applied projects: a mixed planting bed, a treed plaza, and a planted meadow ecosystem. Scaffolding refers to how an instructor systematically builds on students' previous experiences and knowledge. As students' knowledge grows and they transition from lower learning levels (skills and knowledge acquisition > concrete conceptual > abstract thinking) to higher learning levels (problem-solving > problem finding), the instructors shift from direct knowledge-based instruction to providing guidance on complex, nuanced, and principled approaches to solving real-world problems (TAMMINGA & CIANTIS 2014). In essence, the student progresses from structured and instructive learning to more constructive, experiential and self-guided learning where socially-engaged judgment, empathy and even wisdom factor into the process.

As outlined above, the course structure reflects our belief that design students are well served by tacit knowing, or embodied knowledge, a constructivist approach to learning (JOHANNESSON & PERJONS 2014, POLANYI 1966). Essential to the constructivist approach is that learners feel they are active participants in directing their educational process, and that learning is a social activity where students are empowered to share technical and creative problems with their peers as they use various modes of representation. Tacit knowing is supported by manipulating the tools of practice, a process called reflection-in-action, as students iterate their drawings and models (SCHÖN 1985). However, we cannot ignore explicit knowing within this course – what DE JONG and FERGUSON-HESSLER (1996) call procedural knowledge. Students need a base knowledge of key facts regarding plant characteristics and associated environmental needs for healthy plant communities (e. g., soils, climate, hardiness zones). Additionally, students must be introduced to professional standards of contract documentation and construction procedures and protocols. The course activities, processes, and learning modalities, then, must blend formal and informal explicit and tacit learning. In other words, both tacit and explicit knowledge is scaffolded within the course. Throughout the course students are guided through basic concepts of creating human-scale environments with plants, infra-

structure, built form, landform, and ecological processes, while concurrently introduced to the information and skills needed to prepare plant palettes and seed schedules. Additionally, these concepts are paired with visual communication, technology, and technical construction documentation skills; for example, three-dimensional modeling and CAD planting plans and drafting standards. As this is the first and only planting methods course in Penn State's curriculum, our intent is to guide students from knowledge to applied thinking and then translate this constructed knowledge to subsequent design studios.

In the Fall 2020 virtual version of the course, explicit knowledge modalities included faculty-to-student instruction such as conventional online lectures, technology demonstrations, and discussions – all formats that students were used to. But as the semester loomed, we realized we were on course to repeat our Spring 2020 shortcomings on the tacit learning side of the spectrum unless studio format changes were made. Our LMS, Canvas, was largely closed to the students; it required faculty facilitation, which is counter to a constructivist approach to education. Hence, a virtual studio LMS needed to remain open to student directed and facilitated modes of learning. We invited our colleague, emeritus professor and digital design visualization expert Tim Johnson, to interweave several emerging virtual environments to craft a novel Virtual Studio that would accommodate both explicit and tacit styles, and that hosted collaborative whiteboarding, video conferencing, and video technologies. While the resultant model accommodated virtual explicit modes, such as formal desk critiques, presentations, and open document caches, they also embraced vital peer-to-peer learning modalities: small group pin-ups, peer critiques, and two extended design charrettes. Importantly, we soon realized that this de-facto virtual community of practice could also support peer-to-peer co-learning (SCHWEITZER et al. 2008) in ways that encouraged informal, non-class time browsing of peers' work left on virtual desktops – much like the analogue studio settings that students and faculty alike cherished.

Also critical to the Fall 2020 version of the course was maintaining individual student presence in studio, as we wanted to avoid a repeat of the Spring 2020 transition to online instruction that witnessed a drop in student engagement. While some of this drop could be attributed to the worldwide anxiety of the pandemic, post-course evaluations showed that a portion of the decrease in Spring 2020 course engagement can be attributed to the loss of the dynamic nature of the physical studio environment, or "studio presence". Studio presence is a broad concept and has a variety of meanings; however, for this research, the term refers to three concepts: telepresence, social presence, and copresence.

Telepresence is the LMS's capacity to give the learner a feeling of "thereness" or studio embeddedness (SCHROEDER 2002) – a sense that Canvas and Zoom cannot adequately provide. Telepresence is intended to enhance engagement through effective nonverbal communication and visual interaction by establishing student comfort and familiarity within the virtual space.

Social presence is the degree to which students feel they have access to each other's design ideas, technical development, and digital representation strategies (RICE 1993). This form of presence in face-to-face classes is typically supported by the physical spaces we inhabit, e. g., desks or drawing pin-up walls, which can be self-organized by students and changed as needed during and after studio. Research has shown that access to their peers' work reduces learning anxiety by showing that they are not alone and are supported by others, thus improving mental health which, in turn, facilitates even deeper course engagement (JIN 2011). However, as we found in Spring 2020, this was difficult to accomplish within the Canvas LMS

because students could not self-organize peer-to-peer critiques and drawing. While it is true that students could self-organize using other technologies, the fragmentation of their efforts produced barriers in smoothly moving between one community of practice to another. Therefore, the Virtual Studio designed for Fall 2020 includes collaborative whiteboard technologies that mimic the availability and self-organization capabilities of our in-resident studio desks and pin-up spaces.

Copresence refers to a psychological connection to and with another person. Copresence requires that students can actively sense interacting partners and that these partners can reciprocate in sensing them (NOWAK 2001). Copresence is essential in forming and maintaining interpersonal relationships within communities of practice. The Virtual Studio environment supports copresence through video conferencing and collaborative white boards. The white boards support synchronous, multi-user, named cursor tracking and named asynchronous comments. Collectively, these technologies can increase social and copresence.

1.3 Previous Virtual Learning Environment Efforts

Virtual learning environments are not new to the landscape architecture academy. Indeed, research has explored the use of virtual environment and gamed supported pedagogies using SimCity (CHAMBERLAIN 2015) and Second Life (THOMAS & HOLLANDER 2010). Additionally, virtual environments were created to teach targeted concepts such as grading (LI 2016) or to visit inaccessible places through virtual field trips (HUANG 2020). While these efforts have pushed the boundaries of landscape architecture pedagogy, they have also necessitated specialized hardware and fast network connections (CHAMBERLAIN 2015). Additionally, these tools often introduced novel workflows or means of interaction and design visualization that precluded other forms of media (e. g., hand drawing on tracing paper), a necessity for some students without the technological capacities to support specialized virtual interactions. Finally, they also facilitated specific design assignment and tasks and were not intended to serve as the studio itself. Hence, the need for a Virtual Studio that becomes the context for an interactive and blended approach to both tacit and explicit learning and the associated wide array of project deliverable media.

2 Methods

2.1 Virtual Studio Technologies

The virtual studio consisted of four areas: studio desks, lecture hall, pin-up spaces, and lounge. Studio desks consisted of two critical components, a virtual whiteboard and video conferencing (Figure 1). Conceptboard was chosen as the whiteboard software because it is perpetual and provided the ability to upload multiple file-formats: JPEG, PNG, AI, PDF, PSD, DOC, XLSX. Additionally, Conceptboard accepts embedded audio and video files. Conceptboard's drawing tools were useful because they allowed for varying colors, line weights, and recognized mouse and pen-based inputs. Zoom enabled video conferencing. Each student's desk contained direct links to each faculty's Zoom sessions for easy access. The capabilities mentioned above were vital because they supported desk critiques, a central pedagogical class activity. Synchronous desk critiques require redlining and drawing construction documents, details, and complex construction notes. Additionally, the combination of Conceptboard and Zoom facilitated copresence and social presence during class time.

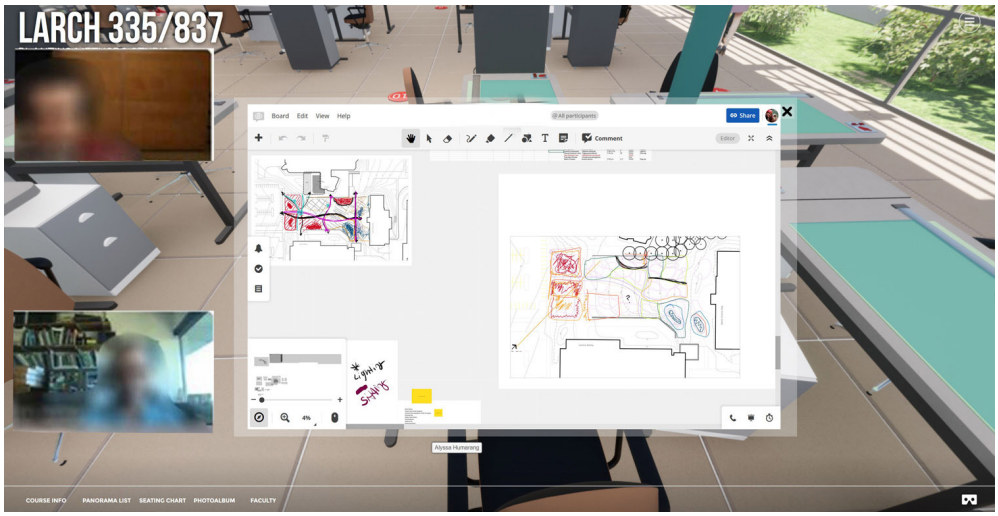


Fig. 1: The Virtual Studio video conferencing desk critique space

The virtual lecture space facilitated explicit knowledge transfer through links to live Zoom lectures and a YouTube repository of pre-recorded technology demonstrations, course materials, and past lectures. Pin-up spaces were created using embeded Conceptboards to facilitate group critiques and discussions. Conceptboard supported copresence during pin-ups through synchronous, multi-user, named cursor tracking, named asynchronous comments, and presenter controls, in addition to the benefits outlined for desk critiques. A lounge was created

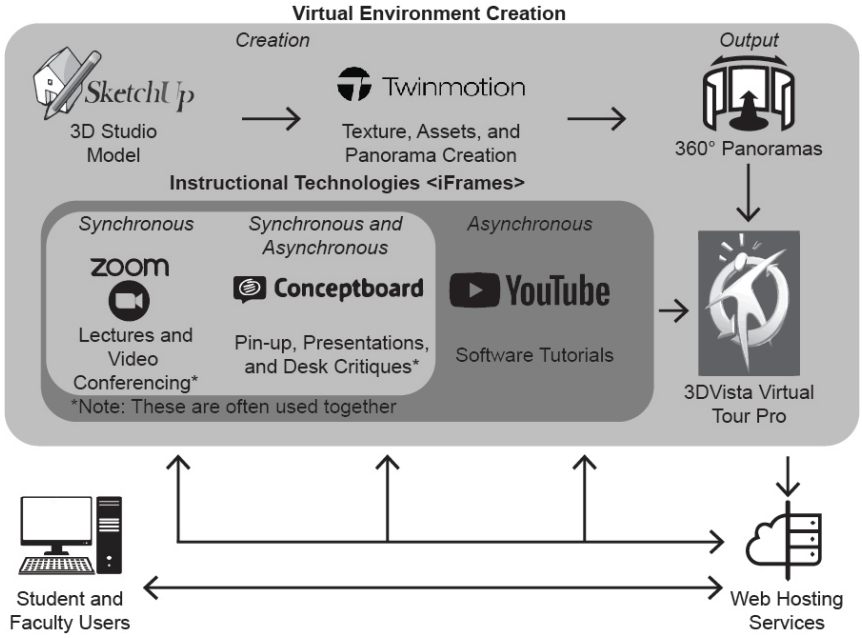


Fig. 2: Virtual Studio workflow and technology integration

to support student mental health and relaxation. Embedded within the lounge were links to local food delivery services, movie watch parties, and music.

The Virtual Studio was modeled in SketchUp 2020. Twinmotion 2020.2 was used to texture and add additional assets (e. g., people, display walls, skylights, plants, sounds) to the model. The studio was built using 120 unique panoramas exported from Twinmotion and imported into 3DVista's Virtual Tour Pro 2020.4.1, an interactive 360-degree virtual tour authoring software. Students and faculty navigated the studio using clickable hotspots to move from panorama to panorama. Hyperlink shortcuts also allowed users to immediately jump to any panorama within the studio. The completed Virtual Studio model contained 175 media objects and over 1,000 images. Learning technologies included Conceptboard, Zoom, and YouTube. Figure 2 outlines the workflow and integration of technologies.

2.2 Survey

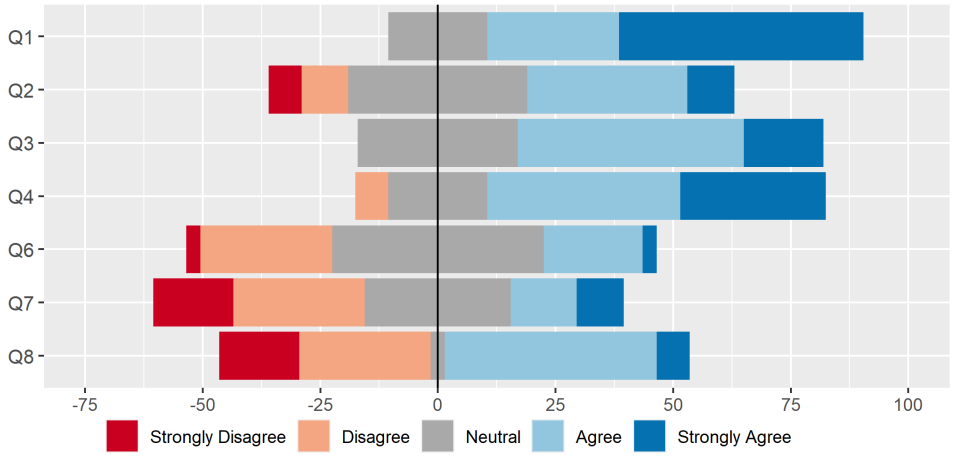
Student perceptions and Virtual Studio experiences were collected through a fifteen-question survey using a mix of five-point Likert scale rating system and open-ended questions. The survey had three parts. Part I questions sought to understand how the students expected the Virtual Studio to affect their learning. Part II sought to understand how students felt about using the Virtual Studio. Qualitative responses to survey questions were coded to identify prominent themes in student responses. Part III documented students' usability and internet connectivity issues, which could have impacted their experiences documented in Part II of the survey. The survey was administered in the twelfth week of the semester. Part III's data was used to identify correlations with perceived effectiveness and technological issues. Collectively, the survey sought to elicit the level to which students felt that the Virtual Studio replicated the interactive and synergistically creative conditions that are hallmarks of an effective, non-Virtual Studio setting. The survey was administered to all 41 undergraduate and three graduate students during a class Zoom session. As the three authors were engaged in the course and determining student grades, an external faculty member held the survey responses until final course grades were submitted.

3 Results

Thirty-three students responded to the survey request, with 29 students fully completing the survey. The response rate was 65.9%.

3.1 Survey Part I – Student Expectations of Learning within the Virtual Studio

Figure 3 presents the Likert-scale survey question results. Part I survey results show that, before the semester, a significant proportion of the students felt nervous about engaging online (52% strongly agreed and 28% agreed). Forty-four percent of the respondents thought the Virtual Studio would increase their learning, compared to Canvas and Zoom alone.



Q1. Before the course, I was nervous about remaining engaged in online learning.
Q2. My learning in this course will increase because of the Virtual Studio.
Q3. I enjoyed using the Virtual Studio.
Q4. It was a good idea to use the Virtual Studio in this course, and it should be expanded upon and used in future virtual courses.
Q6. The Virtual Studio improved social interaction with my peers.
Q7. The Virtual Studio gave the course a continuing presence, similar to face-to-face, which made it easier to stay engaged during and outside of class time.
Q8. The Virtual Studio is a useful learning mode and should become an integral part of mid-level to advanced studios even during non-pandemic times.
Note: The survey had eight questions, presented in the same order here. Question 5 was excluded from analysis due to wording ambiguities that were not detected until after the survey was administered.

Fig. 3: Summary Table of Likert-Scale Survey Question Results (results presented as a % of total respondents; n=29)

3.2 Survey Part II – How Students Felt About Using the Virtual Studio

Part II consisted of several Likert-scale questions (Figure 3) and several open-ended questions. Overwhelmingly, 72% of the students thought using the Virtual Studio was a good idea and recommended it to be used in future virtual courses. However, when comparing the Virtual Studio to face-to-face studio learning, students were split as to what degree the Virtual Studio improved social interaction, with 31% saying it did not, 24% saying it did, and 45% remaining neutral. Additionally, only 15% thought the Virtual Studio created a sense of continued engagement, similar to face-to-face, while 45% did not, and 31% were neutral. However, 52% of the students thought the Virtual Studio was a useful learning mode and that it should be integrated into mid- to advanced-level studios, even during non-pandemic times.

Students reported that the desks linked to individual Conceptboards allowed for favorable synchronous desk critiques and peer reviews (22 students). Additionally, students appreciated the synchronous availability and personal archival aspects of the Virtual Studio space (10 and eight students, respectively). Students liked that the virtual studio "acted like a real classroom" in that it was a space – albeit a digital one – that served as a better learning management system than a series of links in Canvas (10 students).

The coded results of the Part II open-ended question "How did your student-student learning change (either positively or negatively) because of the use of the Virtual Studio" produced several themes. A majority (67%) of students enjoyed using the Virtual Studio, while only seven percent did not. Part II question coding also showed students thought the Virtual Studio was user-friendly (15 students). However, the students did not like the panorama node-based navigation that 3DVista's Virtual Tour Pro requires, suggesting further work is needed to ensure more fluid or direct ways of accessing their desks (six students). Students repeatedly made this point; for example, Student 24 noted:

> Moving to my desk is not that smooth. It is annoying how you move around and can't just click on my desk from the plan view. The same goes for going to someone's desk across the studio.

In response to, "What were your least three favorite features of the Virtual Studio", students predominantly focused on node-based navigation frustrations (19 students). Students noted that instead of navigating the studio space, they relied on the panorama student name list available in the menu below the virtual studio window. However, they still found this less than satisfactory since it was ordered spatially, rather than alphabetically or by a stratified system of locations (six students). Additionally, students noted frustrations with logging into Conceptboard, as it occasionally would require multiple efforts to achieve access successfully. Finally, students indicated that peer-to-peer communication was not as easy as accessing the professors via Zoom.

The coded results for the question, "Describe what features and functions you would like to see added to the Virtual Studio", produced two strong themes: proximity-based peer-to-peer communication (13 students), and live avatars with gaming-like, fluid movement and verbal communication (six students). However, not all students suggested the same communication method: some students suggested proximity video like Gathertown, while others wanted instant messaging, audio, or a notification center.

3.3 Survey Part III – Correlations with Perceived Effectiveness and Technological Issues

Survey results showed no correlation between students' home internet bandwidth speeds and technical glitches and crashes with negative Virtual Studio experiences, although a few students did note minor interruptions. However, for many students, the Virtual Studio provided a stable platform, as 41% of the students never experienced a technical glitch or crash, and 28% only experienced a few instances during the semester. Comparatively, the faculty's experiences were glitch-free.

4 Discussion

Prior to the semester the students were deeply concerned about the prospects for sustained engagement in an online design course format. The Virtual Studio more adequately facilitated informal and formal asynchronous and synchronous peer-to-peer design critiques than Canvas and Zoom alone. The faculty noted increased course engagement compared to the previous semester's online instruction initiated at the start of the pandemic. Additionally, we have some confidence that the Virtual Studio created greater telepresence and social presence than Canvas or Zoom because the technology allowed the students to engage with each other on

their own terms, both during studio and after hours, using their own design processes and media. Indeed, students noted that telepresence was improved over previous online experiences because of the inclusion of familiar materials and spatial qualities within the Virtual Studio. As one student summarized, it "is better than a bunch of links." Additionally, social presence was also notably improved. Students specifically highlighted how the Virtual Studio desks served as a hub for conveniently accessing their Conceptboards and faculty Zoom links. Two specific benefits were noted. First, the Virtual Studio allowed students to collate a visual record of all peer and faculty critiques throughout the semester in a single, navigable space. Due to physical space requirements in face-to-face modes of class, this is often impractical to facilitate. Second, it allowed students to see the cumulative work of their peers. The resultant deeper engagement was also noted by JIN (2011).

Collectively, telepresence and social presence improved students' engagement in the course compared to the previous semester's partially-virtual classes. However, the Virtual Studio in its current form also somewhat limited social presence. First, students noted that not all their peers engaged with the Virtual Studio equally. Unequal engagement quite likely left gaps in tacit peer learning experiences. Several students suggested, and we agree, that more intentional requirements of uploading in-progress work could foster additional peer-to-peer engagement. However, while mandated interim submissions and reviews would increase peer-to-peer engagement, we are not sure if this would lead to deepening tacit peer learning experiences. Required, top-down engagement is counter to the spontaneity and self-organization of democratic communities of practice discussed by SHALINSKY and NORRIS (1986), BROOKS et al. (2002), and WENGER (1999). This suggests a heightened role for student-led peer-to-peer norms, in addition to faculty expectations.

It is unclear if the Virtual Studio created or reinforced copresence, since the subject cohort of students has been matriculating together through the curriculum for several semesters. Therefore, it is difficult to determine if the Virtual Studio supported the creation of deeper communities of practice or if it served to maintain the communities of practice that already existed. Despite these uncertainties, many students discussed copresence limitations. Two specific copresence issues emerged: an inability to know who was actively using the Virtual Studio in real time, and an inability to engage in verbal peer communication intuitively and seamlessly. Finally, most students noted that while the Virtual Studio is a step forward in online learning support, it is not an adequate replacement for in-person studio.

Future research-based development should be able to improve all three forms of presence within the Virtual Studio. Replacing the static panoramas of the Virtual Studio 1.0 with an open world, multi-player gaming environment could improve telepresence, social, and copresence and tacit learning in two ways. First, a more deeply immersive learning experience could be created through the introduction of dynamic movement, lighting, and textures. Second, gaming engines could support the students' ability to inhabit the studio through avatars, as opposed to the current Virtual Studio's node-to-node based movement. The use of avatars could also deepen social and copresence by removing the barriers to initiating video conference and leveraging proximity video chat that supports real-time facial expression animation. Whether students' remote bandwidth and hardware setups could accommodate all these enhancements are open to further investigation.

5 Conclusion and Next Steps

The Canvas LMS + Zoom context is not an effective substitute for face-to-face studio experiences because it does not adequately support tacit learning and studio presence. New LMSs are needed. The Virtual Studio 1.0 supports an emerging framework using a virtual "physical space" that serves as a hub for tacit learning technologies. Additionally, the Virtual Studio begins to create studio presences, specifically telepresence, a critical piece of studio culture. However, copresence is not fully developed within the Virtual Studio space, and future iterations should leverage the open-world, multiplayer game engines for their dynamic and real-time engagement support.

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