Student Experiences in Online Learning Environments: A Comparative Study of Virtual Worlds and Video Conferencing Platforms

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***Abstract*—As educational technologies evolve, understanding how different digital platforms affect learning experiences becomes increasingly important for successful digital education implementation. Despite the widespread adoption of both video conferencing platforms and desktop virtual worlds (DVWs) in online education, limited research examines comparative student experiences across these environments. To address this gap, this study explores: How do students' learning experiences in DVWs differ from those in video conferencing platforms?**

Through three focus group studies with students experienced in both platform types, we conducted a thematic analysis to examine their comparative learning experiences. Our analysis of the collected data identified distinct complementary advantages in each environment. DVWs offer two key strengths: (1) Spatial agency and freedom of movement, enabling autonomous navigation, spontaneous interactions, and immersive engagement that create flow states; and (2) Student-centered learning and creativity, facilitating horizontal power structures, creative expression through avatar customization and environmental building, and collaborative co-creation projects.

Conversely, video conferencing platforms demonstrate two key advantages: (1) Streamlined design and usability, providing efficient communication, easy setup, and technical reliability; and (2) Structured learning advantages, offering focused attention for content delivery, formal presentation contexts, and instructor-centered learning models that support traditional pedagogical approaches.

Our findings suggest that their strengths address different educational needs and contexts. Rather than positioning these platforms as competing alternatives, our research suggests an integrated approach leveraging the affordances of each environment based on specific learning objectives, activity duration, and student characteristics.

***Index Terms*—Desktop Virtual Worlds, Virtual Learning Environments, Video Conferencing, Educational Technology, Spatial Presence, Affordances, Online Learning, Avatar-based Interaction, Human-computer Interaction, Interaction Design, Digital Education, Student Experience**

I. Introduction

The technological medium used for educational delivery represents one of the key factors shaping students' online learning experiences, influencing how they engage with content, interact with peers, and build knowledge [1]. Educational institutions increasingly deliver academic content through a variety of digital platforms, with video conferencing tools such as Zoom and Microsoft Teams becoming especially prevalent. Desktop virtual worlds (DVWs), including platforms like Gather Town, Second Life, Virbela, and Minecraft Education Edition, represent alternative platforms. While both environments facilitate remote learning, they offer different interaction affordances that may influence student educational experiences.

Video conferencing platforms have become common in educational settings, particularly following the abrupt transition to online learning during the COVID-19 pandemic. These tools provide direct, synchronous communication through familiar interface paradigms that resemble traditional classroom structures. Conversely, DVWs offer immersive, spatial environments where students navigate virtual spaces through avatar-based interaction, enabling forms of collaboration and creative expression that extend beyond conventional educational delivery methods [2].

Despite their widespread adoption in educational contexts, research remains limited in understanding how these different virtual environments comparatively affect student experiences. Current literature tends to evaluate these platforms in isolation, focusing on individual platform capabilities rather than examining their relative strengths and limitations from the student perspective. This isolated approach limits our understanding of how different technological affordances support various educational objectives and student needs.

Moreover, there is a need for further research examining the qualitative dimensions of student experiences across different virtual learning environments. Understanding how students perceive, navigate, and engage within these digital spaces is essential. This experiential perspective is crucial for helping designers create more engaging digital learning tools and assisting educators in selecting appropriate platforms for their pedagogical goals. Ultimately, better platform selection can enhance student learning experiences and support academic success. To address this research need, we examine the following research question: How do student learning experiences in DVWs differ from those in video conferencing platforms?

Through three focus group studies involving nine students who had experience using both platform types, we conducted

a thematic analysis to investigate their experiences across both environment types. We focused specifically on desktop virtual worlds rather than VR-based environments because DVWs run on standard computing devices that most students can access, making them more widely available for educational implementation.

Our thematic analysis, informed by technology affordance theory which examines how technological features enable or constrain user actions and experiences [3, 4], identified distinct advantages that each platform offered from the student perspective. Our findings demonstrate that rather than competing alternatives, these platforms provide complementary strengths that address different educational needs and learning contexts, suggesting the potential for strategic integration based on specific pedagogical objectives. This research contributes to educational technology and interaction design literature by providing a student-focused comparative analysis of platform affordances, with broader implications for developing more successful digital pedagogy practices.

II. BACKGROUND

Digital learning technologies have expanded educational delivery methods, creating new possibilities for synchronous, asynchronous, and collaborative learning experiences. Understanding how different technological platforms support or constrain educational activities has become crucial for informed pedagogical decision-making, particularly regarding the distinct affordances of video conferencing platforms versus immersive DVW learning environments.

A. Video Conferencing and Virtual Worlds in Education

Video conferencing platforms, particularly Zoom and Microsoft Teams, have been adopted as the predominant approach to synchronous online education in the United States due to their availability, scalability, and familiar interface conventions. These platforms excel at accommodating large numbers of simultaneous users with minimal technical requirements, making them practical for institutional-wide implementation.

Research supports their educational value. Carmi et al. [5] found positive correlations between students' attitudes toward the learning method, Zoom system usage, and learning flexibility with five learning effectiveness measures (skills, understanding, benefits, involvement, and motivation). Technology Acceptance Model studies further demonstrate that while perceived ease of use and usefulness of Zoom do not directly affect acceptance intention, they significantly influence it through student satisfaction as a mediating variable [6]. Students respond positively to platforms that improve productivity, help achieve study goals, and enhance academic performance. Despite these positive aspects, most students believe video conferencing platforms should be used part-time rather than full-time, preferring integration with conventional learning methods [7].

This preference may result from well-documented limitations that emerge with extensive use. The phenomenon of "Zoom fatigue" affects the majority of users, with studies reporting that most students experience fatigue when using video conferencing for more than five days per week and more than four hours daily [8]. Common impacts include feeling tired, boredom during long sessions, anxiety during video conferencing, preference for camera-off participation, eye health problems, back and spinal issues, and headaches. Quantitative studies indicate that although frustration levels between immersive virtual environments and Zoom are similar, Zoom is associated with higher cognitive fatigue compared to immersive environments [9].

These fatigue-related issues point to broader structural limitations in how video conferencing platforms shape interaction patterns. The constrained interaction model of video conferencing, in turn, affects classroom discourse dynamics. Students report feeling disconnected from peers and instructors, with limited opportunities for spontaneous conversations that characterize both physical educational spaces and DVWs. The binary nature of breakout room systems creates abrupt transitions, and unlike face-to-face settings where students might stay after class for informal discussions, Zoom participants typically exit immediately when sessions end [10].

In contrast to these constrained interaction models, DVW platforms offer a diverse approach to online education, featuring multiple interaction paradigms based on spatial navigation, avatar representation, and immersive experiences for both synchronous and asynchronous learning contexts [11]. These platforms emphasize exploration, environmental interaction, and avatar-mediated social presence, creating substantially different affordances from the streamlined communication model of video conferencing platforms [12].

Research examining these different interaction paradigms highlights complex outcome patterns. Studies show that DVWs significantly enhance knowledge acquisition compared to video conferencing for students with lower initial interest in the content, but for students with higher interest levels, video conferencing produces superior results [13]. This suggests that immersive features of DVWs may act as distractions for highly interested students while benefiting those less engaged with content.

Building on these learning experience differences, studies have also examined how the two platform types create different social interaction patterns. Regarding social presence, DVWs offer avatar-based interaction that creates more spatially-oriented and immersive social dynamics than video conferencing. While students may prefer seeing real faces and expressions in video calls for social bonding, Speidel et al. [14] found that when given a choice between platforms, students who opted for DVW platforms despite the additional effort required rated their overall learning experience more positively than their peers who used video conferencing.

Despite these potential advantages, practical considerations also impact platform adoption. DVWs present implementation challenges that differ from video conferencing platforms. Design complexity, higher implementation costs, and requirements for specialized software and hardware create adoption barriers. Student onboarding remains challenging, with studies

noting usability problems and the need for more time to learn complex navigation systems [15]. The comparisons between well-known systems like Microsoft Teams and completely new platforms like Spatial shows that familiarity significantly impacts user acceptance and platform adoption [16].

These comparative findings underscore the need for a deeper understanding of how students experience these different technological environments. To provide theoretical grounding for examining these experiences, we turn to frameworks that explain how platform design features shape user interactions and learning processes.

B. Theoretical Foundations

Technology affordance theory provides a framework for understanding platform differences by examining their interaction design affordances. Norman [3] conceptualizes affordances as the perceived relationship between an object's properties and users' capabilities that determines potential uses. In educational contexts, these affordances are particularly significant in virtual environments where spatial interaction becomes central to the learning experience, as different platforms enable or constrain distinct types of student actions and engagement patterns.

Complementing affordance theory, research in embodied cognition provides crucial context for understanding how physical interaction metaphors within virtual spaces influence learning. This perspective suggests that avatar-mediated movement and spatial positioning play key roles in cognitive processes and knowledge construction [17]. The embodied learning framework proposes that bodily and environmental information are essential for defining cognitive representations, suggesting that virtual environments that offer spatial affordances may enhance how students interact with and process educational content within digital spaces [18]. Technology-based embodied learning research demonstrates benefits including enhanced knowledge comprehension, improved retention, increased engagement, and reduced cognitive load, though effects may vary based on learning contexts, learner characteristics, or conflicting design approaches [19].

Another critical theoretical concept is student agency—learners' capacity to take intentional actions and exercise meaningful control over their learning environment [20]. This concept is particularly relevant for comparing DVWs and video conferencing platforms because agency emerges from platform affordances and relationships with other students rather than being simply enabled or hindered by external sources, indicating that platform design for social interaction significantly impacts student engagement [21]. Student-centered teaching methods emphasizing learner agency are associated with positive learning outcomes, though individual teaching approaches and attitudes predict success more strongly than institutional factors such as class size or institution type [22].

Together, these theoretical frameworks—technology affordances, embodied cognition, and student agency—provide lenses for understanding how different virtual learning environments may create distinct educational experiences. They suggest that platform features influence not only what students can do (affordances) but also how they cognitively engage with content (embodiment) and the degree of control they exercise over their learning process (agency). These concepts inform our analysis of student experiences across different virtual learning platforms.

III. Methods

We conducted three focus group studies involving nine student participants who had learning experience with both DVWs and video conferencing platforms. Participants were recruited and grouped based on their experience with specific DVW platforms: Group 1 consisted of participants with Gather.Town experience, Group 2 included those with Virbela and Second Life experience, and Group 3 comprised participants with Minecraft experience. This grouping approach facilitated discussions about platform-specific features by allowing participants to build on each other's shared experiences.

A. Participants

The nine participants represented diverse academic backgrounds and experience levels. Ages ranged from 18-35 years, including undergraduate students, graduate students, and post-graduate learners across disciplines such as Computer Science, Humanities, Science, English/Language Arts, and Accounting. DVW experience varied from less than one year to over six years, while video conferencing experience ranged from one year to over nine years. All participants had used both platform types for educational activities, ensuring they could provide comparative insights between the two environments.

B. Data Collection

Focus group sessions lasted 70-90 minutes and were conducted via Zoom with automatic captioning enabled to generate initial transcripts. Sessions were audio-recorded with participant consent. We manually reviewed each transcript against the audio recordings to correct transcription errors and anonymize identifying information. This process ensured data accuracy and facilitated thorough familiarization with collected data.

C. Data Analysis

We employed inductive thematic analysis to identify patterns in participants' experiences across both platform types. While our focus group questions were informed by theoretical frameworks of affordances and student agency discussed earlier, the analysis followed an iterative process allowing themes to emerge from participants' accounts rather than being imposed.

IV. Findings

In the thematic analysis of focus groups, we identified two primary categories of advantages, demonstrating that DVWs and video conferencing platforms fulfill complementary rather than competing roles in online education. Each platform type

offers specific strengths that address different educational needs and learning contexts.

A. Advantages of Desktop Virtual Worlds over Video Conferencing Platforms

1) Spatial Agency and Freedom of Movement: We identified the affordance for independent movement within virtual spaces as a primary advantage of DVWs over video conferencing platforms from the students' perspective. One participant emphasized the unexpected significance of this feature: *"Having the ability to move around the classroom adds so much to the environment that I didn't think would be significant. I mean, in the grand scheme of things, just being able to walk around in a virtual classroom doesn't seem like it would accomplish much. But for me, that spatial freedom made a tremendous difference in my ability to engage with the material being presented."*

The freedom of movement allowed students to actively initiate self-directed engagement within virtual environments. Students could navigate freely between learning areas, interact spatially with learning content embedded in virtual objects, and transition smoothly between class and group activities. This is in contrast to the abrupt shift from main rooms to breakout rooms and vice versa in video conferencing platforms.

These breakout room affordances also presented significant limitations. Students noted the restrictive nature of breakout room management: *"Pretty much I feel for the most part, anytime I'm in a Zoom call that has a chat room and I leave the chat room, I'm going to need the professor to put me back in whatever subgroup I was in."* This dependency on instructor intervention for navigation differed substantially from the autonomous transitions possible within DVWs.

This spatial movement in DVWs enabled spontaneous interactions that felt more natural for students than the structured breakout rooms of video conferencing platforms. Students described how spatial proximity created opportunities for impromptu conversations: *"With Gather.Town, you can just be walking around and happen to run into someone and just talk with them about what you were doing or working on."* This contrasted with video conferencing, where students felt that *"you shouldn't just randomly join someone's breakout room, and start talking to their group about whatever they're doing."*

In addition to facilitating spontaneous encounters, environmental transitions within DVWs helped students maintain engagement during extended learning sessions. Students found it beneficial to move between different virtual spaces based on activity needs: *"In Virbela, when we are many, we are in a hall. But now, when we go to our breakout rooms, then we can be in smaller groups. We change the environment, and now we move from a hall to an open space; you try and change the environment and break into smaller groups."*

DVWs created immersive experiences that altered students' perception of time and engagement. Students consistently reported experiencing flow states where time passed unnoticed: *"I would get on Minecraft at like 3 p.m. I mean, I'd just be there and it will feel and then I would look up again and it'd be like 8 p.m. So I feel when I get into that virtual aspect; its reality kind of surpasses me."* This time distortion indicated deep engagement not typically reported with video conferencing, where students more commonly reported *"watching the clock."*

The spatial design of DVWs also enabled students to be exposed to spontaneous activities and social interactions occurring in shared spaces. One participant mentioned: *"There were cases where we'd be working as a group and then we'd Zoom out and see that there's just students like dancing in the middle of the room or something. So it's just the fact that there can be other things going on that's not just in the groups."*

The spatial audio and proximity-based communication of DVWs created more natural conversation boundaries than the binary room structure of video conferencing. Students favored how *"when you're in a classroom or a group environment with other students, you only hear those students in the classroom. But as soon as you step out, that's when you can hear people walking in the hallway... that small change in the volume of user voice chat, really made a ton of difference in feeling like, oh yeah, that person's actually just far away from me."*

2) Student-Centered Learning and Creativity: A second major theme identified was the shift toward student-centered learning and creativity that DVWs facilitated. This change was evident in how power dynamics and participation patterns changed within these environments. Students observed that *"with Zoom, it's mostly for a professor wanting to do a lecture to students, whereas Gather.Town is more so for the collaboration aspect of it; multiple people wanting to present at the same time."* This shift enabled more horizontal learning structures where *"any individual can have the floor, share their screen anytime, talk to the entire class if they want to."*

The student-centered interaction design of DVWs, combined with in-world building affordances, facilitated multiple pathways for creative expression, representing another significant advantage over video conferencing. The diversity of creative affordances was particularly evident in building-based DVWs such as Second Life and Minecraft: *"Someone's creativeness might come from like adventuring and finding new places around their Minecraft world, But other people might be more creative in actually building something. So Minecraft isn't just about building; it's about exploring, it's about mining... it's like all these things combined make it creative for different people."*

The creativity through avatar customization provided more opportunities for personalization and identity expression than video conferencing platforms. Students could express themselves through avatar customization, username selection, and environmental modification: *"Being able to express yourself with your character and your username and also like what you built and what you did and what you created was a lot nicer to do obviously in Minecraft, you can't really do that in Zoom."* This creative freedom allowed students to bring more of their personal identity into the learning space, increasing investment and ownership of the learning process.

These creative affordances of DVWs were contrasted with the limited creative expression and interactive affordances in video conferencing: *"Minecraft just gives you more space to be creative because you have that freedom there's no one stopping you if you want to go build a skyscraper or if you want to make a farm or whatever; whereas on Zoom, there's not really "too much" creativity involved."* Even when video conferencing platforms offered interactive features, students found them insufficient: *"There's like polls you can do and add-ons you can have to keep people engaged... But I don't think it's comparable to what Minecraft can give you."*

Collaborative creativity was identified as another important aspect of this student-centered design, as creative projects often required collective problem-solving that developed teamwork skills. Students described how working together on creative projects involved *"brainstorming with them; because I mean if we're trying to solve a problem, their creativity is combined with yours too and has a better end result when you work together compared to if you were independent."* This hands-on collaborative approach contributed to enhanced memory formation and emotional engagement, with students noting that DVW experiences were *"more memorable since you are actively doing something and you're involved with it and interacting versus just listening [as you would on Zoom]."*

B. Advantages of Video Conferencing over Desktop Virtual Worlds

1) Streamlined Design and Usability: Our thematic analysis identified streamlined interactions as the primary advantage of video conferencing platforms over DVWs. These platforms excel at direct, straightforward communication and information exchange without the intermediary layers of avatar-mediated interaction or navigational complexity. One participant noted that *"Zoom is much more efficient and if you're actually trying to learn something because it has features like you can share your screen on Zoom to show others to effectively teach them."* Students found this directness especially valuable for instruction requiring rapid feedback responses, where the additional interface layers typical of DVWs might create unnecessary barriers.

The convenience of video conferencing setup was consistently highlighted. Students appreciated how quickly they could *"just send out a Zoom link; hop on it and work on something or talk about it for like 20 minutes."* without the setup time required for DVW environments. The integrated communication affordances created easy information sharing, with students contrasting this to communication complications in DVWs: *"With Zoom, it's easier to talk to people."* Screen sharing affordances enabled easy content presentation and collaborative work on shared documents. The convenience of presenting slides, demonstrating projects, or reviewing documents together was noted as an important advantage over DVWs. This streamlined design made video conferencing particularly suitable for brief, focused interactions, with students recognizing that it worked well for *"shorter things [learning activities]"* where efficiency was prioritized over immersion or extended engagement.

In addition to setup efficiency, technical reliability and widespread familiarity of video conferencing platforms reduced barriers to adoption. During the COVID-19 pandemic, students noted how *"we implemented Zoom and also Google Meet and stuff, just like online learning kind of things. But Zoom was the biggest one that we did use and it did open up more ability to learn during COVID."* Their interaction design ensured more equitable access across different technical proficiency levels and computing resources. The universal reach and relatively low system requirements of video conferencing tools ensured broader adoption compared to DVW platforms that might require specialized software or higher-performance hardware.

2) Structured Learning Advantages: The structured environment of video conferencing better supported concentrated attention for content delivery and lecture-based instruction. Students mentioned that *"Zoom because it doesn't have much distraction, So I feel I would learn more seriously through Zoom rather than Second Life."* This constrained attention channel directed focus more effectively to presenters and shared content when the primary goal was information transmission rather than interactive exploration.

The absence of environmental exploration options eliminated potential distractions during content-focused learning. Students highlighted how the platform's design naturally channeled attention: *"I think for more of a class setting in college, you'd probably learn more on Zoom."* This focused environment was particularly beneficial for complex conceptual learning where maintaining concentration on specific content was critical.

Furthermore, video conferencing created accountability through direct video presence that helped maintain attention for some students. The awareness that instructors and peers could observe engagement levels created social pressure to remain focused: *"If your camera is on, you're less likely to get distracted because your teacher will catch you, whereas if your camera's off and you're distracted... the teacher has no way to tell."* This accountability approach was particularly important for students who benefited from external motivation.

The instructor-centered model was valued for certain types of learning where clear authority and structured information flow were beneficial. Students recognized that *"with Zoom, it's mostly for a professor wanting to do a lecture to students,"* which served important educational functions. The clear separation between presenter and audience supported traditional pedagogical approaches where information flow was primarily unidirectional, with students noting how *"all the focus when in your a large meeting is on the professor or whoever is talking at that moment."*

V. Discussion & Conclusion

Our study revealed that DVWs and video conferencing platforms offered complementary rather than competing advantages, with each platform's strengths addressing the other's

limitations. This finding extends existing comparative research [13, 14] by demonstrating that platform suitability depends on learning objectives and contextual requirements, with neither serving as a universal solution for online education.

The spatial agency identified as the primary advantage of DVWs aligns with embodied cognition research [23]. Our participants experienced autonomous movement that facilitated engagement, extending previous findings about spatial presence in virtual environments. This navigational freedom promoted learning by supporting independent exploration and encouraging student ownership of the learning process. Students described flow states and altered time perception during DVW use. This supported research showing that immersive environments create task engagement that enhances motivation and learning [24].

This spatial freedom in DVWs also enabled spontaneous interactions through proximity-based communication. This represented an important contrast to the structured communication patterns of video conferencing. This finding supports research on the importance of informal learning interactions in educational contexts. DVWs may better resemble the social dynamics of physical learning environments [25]. The ability to overhear conversations, observe peer activities, and initiate impromptu discussions provides peripheral awareness and social learning opportunities [26]. These opportunities are similar to those in traditional classrooms but absent from video conferencing platforms.

Previous research by Di et al. [13] found DVWs beneficial primarily for less engaged students. Our participants described spatial agency as enhancing engagement across different interest levels. This difference may reflect variations between laboratory settings with brief exposure and authentic educational contexts where students develop familiarity with platform affordances over extended periods [27].

The student-centered learning facilitated by DVWs supports literature on learner agency and constructivist pedagogy [20]. Our participants described horizontal power structures where students navigated freely between learning areas and joined groups autonomously. This aligned with research showing that student-centered approaches improve learning outcomes [22]. This represented a notable difference from the instructor-mediated group management typical of video conferencing platforms.

The creative expression affordances in building-based platforms such as Minecraft and Second Life extended previous work on digital creativity in educational contexts [28]. Students expressed identity through avatar customization, environmental modification, and collaborative co-creation projects. These affordances provided multiple modalities for demonstrating understanding, suggesting that DVWs support diverse creative expression pathways for students. Students also described collaborative creativity through shared building projects, revealing how platform design shaped collective problem-solving approaches.

Our findings regarding structured advantages of video conferencing revealed positive aspects in educational contexts. Features such as constrained navigation, focused attention interface, and streamlined communication functioned as valuable affordances for lecture delivery and formal instruction. This added to "Zoom fatigue" research [8] by suggesting that negative experiences may result from inappropriate platform selection or usage rather than inherent technological drawbacks. This reframed negative perceptions by demonstrating that structural constraints can serve productive educational purposes when aligned with appropriate learning objectives, rather than representing inherent platform limitations.

A. Implications for Educational Practice

These advantages of each platform demonstrated their complementary rather than competing nature. The complementary relationship identified in this study has implications for educational design and institutional technology adoption. Rather than seeking single-platform solutions, institutions could develop integrated approaches using the strengths of each environment. Our findings suggested that DVWs work well for extended collaborative projects, creative assignments, and community-building activities. Video conferencing excelled for lecture delivery, formal presentations, and brief focused interactions.

This integration approach differs from most institutional practices that often standardize on single platforms for administrative convenience. Our findings suggested that educational value may require platform diversity, with implications for instructor training, technical support, and student orientation programs. The investment required for multi-platform implementation may be justified by enhanced learning experiences across diverse pedagogical contexts.

Our findings on platform diversity were supported by our separate study with educators, which revealed similar complementary findings regarding platform integration. However, this study involved a small sample of participants from diverse academic backgrounds using four different DVW platforms. Future research with larger samples of students across more varied DVWs could provide broader comparative insights and strengthen the generalizability of findings across different educational contexts.

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REFERENCES

[1] M. Garlinska, M. Osial, K. Proniewska, and A. Pregowska, "The influence of emerging technologies on distance education," *Electronics*, vol. 12, no. 7, p. 1550, 2023.

[2] Y. Sun and M. Gheisari, "Potentials of virtual social spaces for construction education," *EPiC Series in Built Environment*, vol. 2, 2021.

[3] D. Norman, *The design of everyday things: Revised and expanded edition*. Basic books, 2013.

[4] I. Hutchby, "Technologies, texts and affordances," *Sociology*, vol. 35, no. 2, pp. 441–456, 2001.

[5] G. Carmi, "E-learning using zoom: A study of students' attitude and learning effectiveness in higher education," *Heliyon*, vol. 10, no. 11, 2024.

[6] L. K. Wedari, A. N. Fatihah, and T. Rusmanto, "Zoom application acceptance in online learning: An analysis with the technology acceptance model," *International Journal of Information and Education Technology*, vol. 12, no. 9, pp. 821–830, 2022.

[7] Z. Khrisat and H. N. Fakhouri, "Impact of e-learning tools (moodle, microsoft teams, zoom) on student engagement and achievement at jordan universities." *International Journal of Interactive Mobile Technologies*, vol. 18, no. 18, 2024.

[8] A. A. Permana, A. Kusnadi, A. N. Marpaung, E. D. Marcela, N. Yuasan, and S. Fauziyah, "Effect of zoom fatigue on health and learning loss in students during the covid-19 pandemic," *Jurnal Inovasi Teknologi Pendidikan*, vol. 10, no. 1, pp. 22–32, 2023.

[9] A. Jaiswal, T. Babic Williams, J. M. William, and A. Madni, "Assessing the impact of virtual reality and zoom on learning experiences in instructor training program," *Future in Educational Research*, 2025.

[10] M. Gordon, "Synchronous teaching and learning: Onground versus zoom," *International Journal of Education and Human Developments*, vol. 6, no. 3, pp. 11–19, 2020.

[11] A. Ebrahimi and M. L. Maher, "Designing presence and place: A framework for engaging student interaction in desktop virtual world learning environments," in *2024 IEEE Frontiers in Education Conference (FIE)*. IEEE, 2024, pp. 1–9.

[12] A. N. Ebrahimi and H. Ramaprasad, "Interaction design strategies for socio-spatial embodiment in virtual world learning," *Virtual Worlds*, vol. 4, no. 3, 2025. [Online]. Available: https://www.mdpi.com/2813-2084/4/3/30

[13] A. F. Di Natale, C. Repetto, and D. Villani, "Desktop-based virtual reality social platforms versus video conferencing platforms for online synchronous learning in higher education: An experimental study to evaluate students' learning gains and user experience," *Journal of Computer Assisted Learning*, vol. 40, no. 6, pp. 3454–3473, 2024.

[14] R. Speidel, E. Felder, A. Schneider, and W. Öchsner, "Virtual reality against zoom fatigue? a field study on the teaching and learning experience in interactive video and vr conferencing," *GMS Journal for Medical Education*, vol. 40, no. 2, p. Doc19, 2023.

[15] G. Sadanala, "Journey to the virtual realm: transforming student online orientations with 3d desktop virtual reality," Ph.D. dissertation, University of Missouri–Columbia, 2023.

[16] M. Chessa and F. Solari, "The sense of being there during online classes: analysis of usability and presence in web-conferencing systems and virtual reality social platforms," *Behaviour & Information Technology*, vol. 40, no. 12, pp. 1237–1249, 2021.

[17] E. R. Chrastil and W. H. Warren, "Active and passive contributions to spatial learning," *Psychonomic bulletin & review*, vol. 19, pp. 1–23, 2012.

[18] C. Tuena, S. Serino, E. Pedroli, M. Stramba-Badiale, G. Riva, and C. Repetto, "Building embodied spaces for spatial memory neurorehabilitation with virtual reality in normal and pathological aging," *Brain Sciences*, vol. 11, no. 8, p. 1067, 2021.

[19] B. Zhong, S. Su, X. Liu, and Z. Zhan, "A literature review on the empirical studies of technology-based embodied learning," *Interactive learning environments*, vol. 31, no. 8, pp. 5180–5199, 2023.

[20] E. McGivney, "Interactivity and identity impact learners' sense of agency in virtual reality field trips," *British Journal of Educational Technology*, vol. 56, no. 1, pp. 410–434, 2025.

[21] M. H. Stenalt, "Researching student agency in digital education as if the social aspects matter: students' experience of participatory dimensions of online peer assessment," *Assessment & Evaluation in Higher Education*, vol. 46, no. 4, pp. 644–658, 2021.

[22] R. J. Yoder, D. Bobbitt-Zeher, and V. Sawicki, "Understanding the use of student-centered teaching methods in undergraduate chemistry courses," *Research in Science Education*, vol. 51, no. Suppl 2, pp. 845–863, 2021.

[23] M. Farina, "Embodied cognition: dimensions, domains and applications," *Adaptive Behavior*, vol. 29, no. 1, pp. 73–88, 2021.

[24] C. R. Guerra-Tamez, "The impact of immersion through virtual reality in the learning experiences of art and design students: The mediating effect of the flow experience," *Education Sciences*, vol. 13, no. 2, p. 185, 2023.

[25] A. Ebrahimi, "Empowering online learning: Ai-embedded design patterns for enhanced student and educator experiences in virtual worlds," in *Companion Proceedings of the 2023 Conference on Interactive Surfaces and Spaces*, 2023, pp. 84–88.

[26] N. Najjar, A. Ebrahimi, and M. L. Maher, "A study of the student experience in video conferences and virtual worlds as a basis for designing the online learning experience," in *2022 IEEE Frontiers in Education Conference (FIE)*. IEEE, 2022, pp. 1–8.

[27] X. P. Lin, B. B. Li, Z. N. Yao, Z. Yang, and M. Zhang, "The impact of virtual reality on student engagement in the classroom–a critical review of the literature," *Frontiers in Psychology*, vol. 15, p. 1360574, 2024.

[28] S. Bourgeois-Bougrine, N. Bonnardel, J.-M. Burkhardt, B. Thornhill-Miller, F. Pahlavan, S. Buisine, J. Guegan, N. Pichot, and T. Lubart, "Immersive virtual environments' impact on individual and collective creativity: A review of recent research." *European Psychologist*, vol. 27, no. 3, p. 237, 2022.

[29] Anthropic, "Claude 3.7 sonnet," AI system, 2025. [Online]. Available: https://www.anthropic.com/claude