Multimedia Showdown: A Comparative Analysis of Audio, Video and Avatar-Based Communication

Joseph Tu*
joseph.tu@uwaterloo.ca
Stratford School of Interaction Design and Business,
University of Waterloo
Canada

Arielle Grinberg
a2grinberg@uwaterloo.ca
Department of Management Science and Engineering,
University of Waterloo
Canada

Mark Hancock
mark.hancock@uwaterloo.ca
Department of Management Science and Engineering,
University of Waterloo
Canada

Lennart E. Nacke
lennart.nacke@acm.org
Stratford School of Interaction Design and Business,
University of Waterloo
Canada

Figure 1: The virtual space for this study was a mocked-up place of the American television sitcom *Friends*.

ABSTRACT

Our new work culture relies heavily on online meetings and computer mediated communication (CMC). However, making an online meeting engaging while keeping communication productive is a major challenge. We collected quantitative data from the user engagement scale (UES) and qualitative data from semi-structured interviews to investigate how user engagement differed. Using the gamified web-conferencing platform Gather, we compared four communication channels: (1) audio-only, (2) audio and video (no avatar), (3) audio and avatar (no video), and (4) audio and video and avatar. We began qualitative data analysis using reflexive thematic analysis. Although the UES results did not reveal significant differences, the preliminary results from the thematic analysis such as people prefer communication platforms designed for specific use cases because video makes them feel more self-conscious, while avatars make them feel more represented. Lastly, we provide a work-in-progress applied definition of user engagement in communication channels with their perspective on individual engagement constructs.

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in collaborative and social computing**.

KEYWORDS

engagement, communication channels, communication tools, virtual environment

ACM Reference Format:
Joseph Tu, Arielle Grinberg, Mark Hancock, and Lennart E. Nacke. 2023. Multimedia Showdown: A Comparative Analysis of Audio, Video and Avatar-Based Communication. In *Companion Proceedings of the Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '23 Companion), October 10–13, 2023, Stratford, ON, Canada.* ACM, New York, NY, USA, 7 pages. https://doi.org/10.1145/3573382.3616081

1 INTRODUCTION

A productive workplace is based on effective communication. We now use online tools to communicate more than we used to, for education [9, 46, 51], online conferences and workshops [6, 33, 38], and remote work [5, 15, 58] because of the COVID-19 pandemic. However, online communication can feel constrained. Bakker et al.

*Author is affiliated with the Department of Systems Design Engineering, University of Waterloo

CHI PLAY '23 Companion, October 10–13, 2023, Stratford, ON, Canada

[3] found that engagement affects online work. Most online communication tools limit interactions (and, with it, engagement). People may be more interested in interacting online if these technologies incorporate game elements. In both Computer-Mediated Communication (CMC) and Human-Computer Interaction (HCI), understanding user engagement in virtual environments is essential [31, 62]. For example, Baker et al. [2] experimented with avatar-mediated communication to help shy, introverted users cope with social isolation. Ratan et al. [53] have explored how avatar and social presence can affect one's decision via text-based communication, also known as the Proteus effect [61]. In addition, Oh et al. [48]'s systematic review explains how and when it improves virtual user experience (UX). However, we need more information about how engagement affects UX across different communication channels, particularly in a gamified communication tool such as Gather (mainly used for education, online conferences, workshops, and remote work). In this paper, we look at how user engagement differs across various communication channels as new types of interactions and web tools become more widespread: verbal communication (Audio), non-verbal communication (Video), and a graphical image representation (Avatars) in Gather[1] because user engagement is critical to creating effective online communication [34].

We examine engagement in online meetings in a specific virtual environment as an intersection of gaming and web conferencing through these research questions:

(RQ1) How does user engagement differ in each communication channel (Channel A: Audio, Channel B: Audio + Video, Channel C: Audio + Video + Avatars, Channel D: Audio + Avatars)?

(RQ2) How do Audio, Video, and Avatar communication channels compare to each other regarding benefits and trade-offs?

To answer these research questions, we used a mixed-methods approach. We administered the User Engagement Scale (UES) to assess standard engagement constructs across each communication channel. A semi-structured interview is used to dive more in-depth on specific engagement constructs, which is accessed by a hybrid thematic analysis (TA). We also collect participant demographics. In summary, we highlight how combinations of communication channels can affect one's engagement, whether it increases, decreases or remains neutral (no change). Based on O'Brien et al. [50]'s definition of the User Engagement Scale constructs, we use communication channel elements to assess engagement and collaboration. We plan to identify three collaborator roles (facilitators, observers, space architects) that affect engagement. Combinations of communication channels play a crucial role in promoting engagement and collaboration, particularly in how the communication tool is used [31, 62]. For example, using the three combinations of communication channels (Audio, Video, and Avatar) can create a sense of presence, which is particularly useful for events like online Hackathons or the Global Game Jam [20, 40]. The purpose of categorizing roles is to determine the effectiveness of collaboration in professional settings. For example, companies may want to investigate how co-located events affect engagement and collaboration.

[1]Gather: https://www.gather.town/

2 RELATED WORK AND GATHER

The shift in technology has made online communication tools indispensable. Research on online communication tools has become increasingly relevant in Human-Computer Interaction (HCI). For example, Bos et al. [8] studied the effects of four communication channels (face-to-face, video, audio, and text chat) and how effective video and audio conferencing groups were. Virtual teams require engagement, especially when collaborating remotely [4, 43]. For avatar communication, different communication modalities may involve different levels of information richness according to media richness theory [17]. In the last century, we have moved from text-based computer-mediated communication to multi-modal communication (e.g., including audio and video). Researchers have mostly studied how computer-mediated communication may affect interpersonal relationships because of the lack of nonverbal cues like facial expressions, body language, and gestures [56, 57] or multi-modal communications, as well as how it may affect online communication, which is affected by gender [29]. Although interactive aspects of online communication tools can aid in increasing online learning [22], Cao et al. [12] argue that we need to know whether these findings will hold across various communication channels. For example, Fish et al. [23] found that video calls are a good way to talk to people remotely.

Game elements are building blocks that are characteristic of games and, respectively, gamified systems [24] which are essential for engagement [1, 11, 39]. However, it is important to determine what elements could affect engagement [41]. For example, Bonsignore et al. [7] have looked at platforms for collaborative learning by examining how Alternate Reality Games (ARG) facilitate engagement through narrative and game mechanics. Research has shown how game elements like badges can act as a powerful motivator in educational contexts [18], with evidence demonstrating that points, levels, and leaderboards are effective means to increase short-term performance and engagement [42, 45]. Latulipe et al. [37] have discussed how gamification elements increase user engagement despite challenges presented to the user. On the contrary, adding game elements to a system without a specific purpose has raised criticism in gamified applications used for education [14, 32, 60]. Chee and Wong [14] state: "The mere inclusion of meaningless points, badges, and bright colours, which serve as the catalysts to engagement without full comprehension of their purpose or reason of attainment, fails to make a gaming experience fun and engaging." In short, incorporating gamification (such as avatars) in an online virtual environment is a crucial consideration owing to its potential to elevate participants' involvement and motivation, culminating in enhanced contentment and efficacy of the meeting.

Avatars are not exclusive to video games, however, they are a form of mimicry play and embodiment [25, 30, 54]. The importance of an avatar is not about the playable characters but the focus on how players engage and act as agents in a fictional world [36]. In other words, the avatar becomes an extension of the player's body via the interface of a screen, speakers, and controllers [52]. A literature gap exists on how avatars affect engagement in an online communication tool (as part of a virtual world). Nowak and Fox [47] notes the importance of considering the inferences and attributions for avatars as long as the researchers provide clear conceptual

definition, or "it difficult to generalize or fully understand the effects of avatars on communication processes." Our study focuses on 2D game elements, which Gather provides on their platform. The virtual environment can attribute certain mental states (e.g., beliefs, values, goals, feelings, attitudes) to the virtual character [26]. Social interaction is a form of embodied thinking in the concept of modern video games [27]. However, more information about how interaction changes in an online communication tool like Gather is needed. The ability to build specific game-like representation spaces could change how the users interact with one another. For example, proximity chat could create new engagement opportunities in online interactive art conferences [38]. As stated by Gee [27], the virtual environment of Gather could cause "us to act in the real world in ways that change it to resemble or model simulation better."

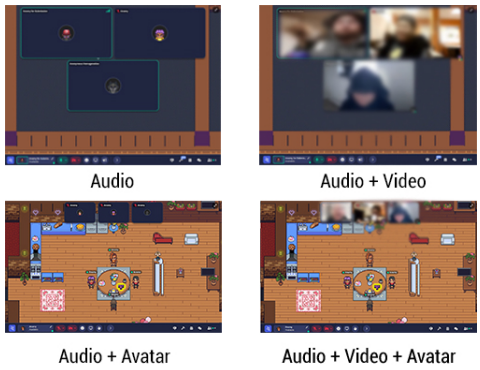

Figure 2: Various conditions in Gather

2.1 Platform: Gather

In this paper, we consider Gather to be a gamified web-conferencing platform: *a virtual environment used for communication with two or more people within the virtual space.* Gather is chosen as the main platform of the study because we can isolate each communication channel (audio, video, and avatar). We created an empty virtual space for Channel A: Audio and Channel B: Audio + Video conditions (similar to a Zoom meeting). Gather has four particular features within its virtual space: (1) the spotlighting feature allows the users to broadcast throughout the virtual world; (2) proximity chat is a feature in which a user can only hear other users within an allocated space; the audio gets louder if users are within the vicinity of one another; (3) private spaces act similarly to a breakout room, which allows users to be in a small meeting while isolating communication outside of that space; (4) Gather allows a space's owner to create interactive elements.

3 METHODOLOGY

User engagement is often defined by the depth of a user's cognitive, temporal, affective and behavioural investment when interacting with a digital system [49]. To measure user engagement in Gather, we decided to use the User Engagement Scale (UES), a 31-item experiential questionnaire, because "the UES (or items derived from it) has been used to evaluate engagement in a range of settings" such as social networking systems and video games within the HCI domain [59]. A semi-structured interview was then conducted because it provided a flexible structure allowing us to collect new exploratory data relevant to our research topic. Open-ended questions were asked to explore the participant's thoughts, presence, engagement, and concerns about online communication tools [16]. Before the interview, participants were also asked to complete a demographic survey (see Open Science Framework)[2] that covered their age, gender, ethnicity, education, as well as their online communication habits (before COVID-19 and during COVID-19). This study was approved by the University of Waterloo Research Ethics Board (REB no. 43455). Following the ethical research guidelines, the consent ensured that participants were free to end the interview at any given time or not to answer specific questions (neither occurred during the interview). At the end of the study, participants were given a thank-you letter and were informed to contact the researchers if there was any sensitive information that needed to be retracted before publication.

A general power analysis program (GPOWER[3]) was used to determine the appropriate sample size for our study [19]. We assumed an effect size of $f \approx 0.43$, α, based on previous literature reported from other studies using the UES scale [50], error probability = 0.05, and a power of a statistic test to be at least 0.8. Based on our power analysis assessment, 64 participants between-subjects were required (16 participants recruited per four conditions), noncentrality parameter (λ) ≈ 11.83, critical F ≈ 2.76 , numerator df = 3, and denominator df = 60, and power ≈ 0.81. Chandler [13] recommends activities within a breakout room should be designed to accommodate small groups of 3–5 participants, focusing on acclimating them to the online platform and providing clear directives for the session. Therefore, each session had a range of 3–5 participants. Our participants were from different nationalities, including Argentina, Australia, Canada, France, Lithuania, South Africa, the United Kingdom, the United States, and Venezuela.

There were two tasks to answer **RQ1** and **RQ2**: **(1)** Charades: This task remained the same for all channels. For example, in Channel A, participants were only allowed to use sounds (without visual aid) to guess. **(2)** Storytelling: Participants were asked to tell a short two-minute personal story. We allowed participants to make up stories on how they pleased. For example, if the theme of the story was "Horror," participants in Channel A only used sound to enhance the storytelling experience, whereas, in Channel B, they could use facial gestures, conversely in Channel C and D, use their avatars such as mimic running away, or have others be involved in their story with a sense of space. As this is a work-in-progress, we had a third task to understand how collaboration works with avatars (in terms of video on and off). We do not report this as the **main result (MR)**, but we do plan to build upon engagement constructs in section 5. Participants were asked to collaborate by designing a "Halloween Theme Space" together. After the participants completed the design, they were asked to share a story about the space they created collaboratively.

[2]OSF Link: https://osf.io/69vd5/
[3]GPOWER: https://stats.idre.ucla.edu/other/gpower/

3.1 Analysis

The interview data were analyzed using hybrid reflexive thematic analysis (RTA), which draws from reflexive and codebook TA types [10]. The statistical tests were conducted in RStudio[4]. We conducted a one-way ANOVA across the four conditions as this allowed us to see the differences between the means and distributions of each group [35]. The normality and homogeneity of variance were checked. Three or more researchers reviewed all interview transcripts. The audio recordings were transcribed in *Dovetail*, and were edited by at least three researchers to check for potential errors. This allowed the researchers (coders) to familiarize themselves with the data. Participant transcriptions were all under 30 minutes. At the time of this study, we consider all authors to have strong knowledge of game user research. One of the authors has worked directly with Gather's API system. We had four researchers (coders) do line-by-line coding on the first 12.5% of the data set to create the first initial codebook (two interview transcripts from each condition). Differences in the tags created in the initial codebook stemmed from researchers having different opinions on the codes. Thus, in 16 sessions averaging around 1 hour, all researchers had to collaboratively discuss, mediate, decide, merge, and resolve all the conflicts that emerged throughout the line-by-line coding to finalize the first codebook. Consequently, the second codebook was derived from the next 12.5% of the data set (two interview transcripts from each condition), while creating a flat coding and hierarchical coding framework model [21]—relevant to engagement and researchers' respective communication modality. Researchers had to dispute all conflicts similar to the first initial codebook to finalize the codebook. Any new relevant tags were merged when possible while keeping new entries open to interpretation under the flat coding and hierarchical coding framework model. Any codes irrelevant to the research question were labelled as "miscellaneous." To capture the essence of each theme, affinity clustering was created on a Gather's whiteboard. To generate these themes, we needed to ensure they fit thematically (i.e., no contradictions) and were not too broad. We decided on initial themes based on the frequency of recurring codes. After creating an initial theme, the researchers returned to each recording to check for missing important points. The themes were refined through multiple iterations; the final themes are presented in the findings below. Our theme development and reporting focused on data directly related to the research question.

3.2 Recruitment and Participants

We recruited participants using a combination of the User Interviews[5] platform and social media posts by our research labs. In total, we recruited 67 participants between the ages of 18–61 (M = 35.56 years, SD = 11.14 years), and all participants were familiar with at least one or more online communication tools (e.g., Microsoft Teams, Zoom, WebEx). The questionnaire had a *test question* to ensure participants filled out the survey correctly: "Please select strongly agree." Participants who did not select 'strongly agree' were excluded from the statistical analysis. In total, the following participant's data were omitted for statistical analysis: Channel A (P16, P35, P38), Channel B (P1, P46), Channel C (P39), Channel D (P23), withdrawn (P52), and dropped (P64). We acknowledge that additional six participants were not recruited to replace the omitted data for the statistical analysis because it would be very difficult to maintain an even distribution across each group. We did consider bootstrapping. However, the displacement of six participants did not yield many changes and thus was not included in this paper. The omitted data is kept on the Open Science Framework[2] for credibility purposes. Qualitative data from these participants were still analyzed because common themes were derived from the semi-structured interview data. All participants were awarded $10 USD gift card on the User Interviews platform. Participant's data were saved in Dovetail[6] for thematic coding; their ID preceded with a 'P' (e.g., *P2*) for reference purposes.

[4]RStudio: https://www.rstudio.com
[5]User Interviews: https://www.userinterviews.com/

4 RESULTS

In this works-in-progress paper, we will only focus on the preliminary results **(PR)**.

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Condition	3	0.053	0.018	0.122	0.947
Residuals	53	7.663	0.145		

Table 1: No significant results across the conditions in terms of UES

4.0.1 One-Way ANOVA. We conducted a one-way ANOVA across the four conditions as this allowed us to see the differences between the means and distributions of each group [35]. The normality and homogeneity of variance were checked. Bartlett's $K^2 = 0.58899$, $df = 3$, $p = 0.8989$ and from the Table 1, looking at the p-value we cannot reject the null hypothesis because there are no significant differences in global engagement between experimental conditions. From the ANOVA results, we do not report the Tukey Post Hoc in this paper as it is insignificant. Therefore, the rejection of the null hypothesis often leads to further investigation to determine the practical significance and implications of the observed difference. We continue to analyze the four subscales of engagement, however, the preliminary results **(PR1)** showed that none of the sub-scales showed significant differences between conditions. It is important to note that the rejection of the null hypothesis in ANOVA does not indicate which specific groups are different from one another, thus we focus on our thematic analysis findings to answer **(RQ2)** to understand the benefits and trade-offs of using one or more than one communication channel.

4.1 Thematic Analysis Preliminary Findings

4.1.1 ***(PR 2)****: Video Is Good For Engagement But Avatars Are Better For Presence.* A majority of participants voiced a preference for enabling their video during communication, citing feelings of speaking into a vacuous space or being unsure of the existence of others. Such uncertainties of interlocutor presence can prompt a sense of loss, leading to lowered engagement. Participants expressed that the avatar fostered a sense of co-presence, instilling a feeling that another person was present alongside them. Interestingly, participants

[6]Dovetail: https://dovetailapp.com/

who preferred not to use video feeds reported feeling self-conscious about their appearance. Proximity chat, privacy rooms, and interactive elements with the ability to move created a sense of space for participants. The ability to move freely within the virtual environment instilled a greater sense of connectedness to the virtual space, while still enabling them to observe ongoing interactions within the vicinity. Participants highlighted the potential for a spatial awareness that can emerge through the provision of dedicated workspaces [28]. For example, the experience of encountering other avatars and being unable to pass through them imbued a feeling of spatial presence within the virtual environment.

4.1.2 ***(PR 3)****: Video Makes People Feel More Self-Conscious While Avatars Make Them Feel More Like They Are Being Represented.* Participants emphasized the significance of being prepared and attentive to self-consciousness. Concerns regarding personal presentation and environmental factors that may be captured on camera were noted to hinder conversation and engagement. While they acknowledged the potential for increased engagement, they also expressed discomfort arising from uncertainties surrounding their appearance and unfamiliarity with other participants because they stressed the idea of "first impression counts'. Participants in both Channel C and D (where avatars were present), reported experiencing a sense of self-representation, as they could visually perceive a virtual resemblance of themselves or how they wished to be represented, alleviated the idea of being less self-conscious as they were moved focused on the avatar (even with the video-on in Channel C). Participants reported that extended periods of having their video on could be taxing and draining, leading to discomfort and reduced engagement. During the semi-structured interviews, we observed that some Channel B and C participants would turn off their videos due to fatigue. However, some participants indicated they would leave their video-on to contribute valuable research contributions and considered it a form of remuneration.

4.1.3 ***(PR 4)****: Each Communication Channel Has A Specific Use Case.* Collaboration occurs mainly in screen sharing or private rooms/spaces. Participants reported that screen sharing is a key aspect of their collaborative work, typically in the third task. Screen sharing facilitates a shared visual experience, enabling all participants to view the same content simultaneously [28, 55]. However, some participants suggested that the current screen-sharing capabilities could be improved by incorporating a zoom feature for enhanced visibility, particularly when presenters are using large screens. Participants noted that large screens can make it difficult to discern details, stating that *"it can be hard to see what's on the screen at times."* (**P43**)

5 DISCUSSIONS

As this is a work-in-progress, we cannot conclude that the communication channels differ in engagement, based on our preliminary results **(PR1)** from the statistical analysis. We plan to look deeper into the thematic analysis to identify what contributes to each individual construct of engagement **(RQ1)**. Using game elements, particularly avatars, can positively impact engagement and collaboration during virtual interactions. Participants in channels where avatars were present reported feeling a sense of self-representation, which can enhance engagement by providing a feeling of co-presence and spatial awareness **(RQ2)**.

In addition, avatars can reduce feelings of disconnection from the environment and enhance the ability to perceive other individuals in the vicinity, potentially leading to increased engagement. However, some participants in the study reported feeling a sense of reduced attention and engagement when using Channel B, despite being able to see other participants on their screens. In latent terms, looking directly at the screen (eye gaze) is not the same as making eye contact with someone online. From our preliminary results, participants reported that the presence of background noise could be a source of distraction during conversations, thus impeding their ability to comprehend and follow the discussion [44] effectively. Because of this, all people in a conversation must ensure that their environment is good for talking. Furthermore, participants expressed dissatisfaction regarding their limited ability to participate in group discussions, resulting in them muting their microphones during the conversations, leading to isolation and loneliness. As we continue analyzing our results in this work-in-progress, it is important to balance the benefits of self-representation through avatars and the potential negative effects of video fatigue on engagement levels.

5.1 Applied Definition of User Engagement in Communication Channels

We plan to observe the individual constructs and map them to O'Brien et al. [50]'s work in relation to thematic analysis results and observational data (currently still work-in-progress). We hypothesize the following in Table 2:

Constructs	Engagement Definition Applied in Communication Channels
Aesthetic Appeal (AE)	The users' perception of the visual appearance of Gather: **Audio:** Minimal to some visual appeal of the user's profile (lighting up, gif, etc) **Video:** Visual appeal of the video frames of participants on screen **Avatar:** Visual appeal of characters, objects, and the virtual environment
Endurability (EN)	Users' overall evaluation of the experience, its perceived success and whether users would recommend the communication channel to others. **All:** Depends on the task or objective of the communication
Felt Involvement (FI)	Users' feelings of being drawn in, interested, and having fun during the interaction. **Audio:** No involvement, unless it's audio task related **Video:** Involvement comes from gestural cues. Ex; smiles, hands, and etc **Avatar:** Involvement mainly derived from interactions are embedded within the virtual space
Focused Attention (FA)	Users's concentration of mental activity in Gather **Audio:** Listening or speaking **Video:** Being comfortable on video (self-conscious) **Avatar:** Virtual Environment; users moving around, design space, reactions, embedded tools (whiteboards, pianos, Tetris), and presence
Novelty (NO)	Users' level of interest in the task and curiosity evoked by the system and its contents **Audio and Video:** None **Avatar:** Being able to move (pace around), embedded interactions, customization
Perceived Usability (PUs)	Users' affective (e.g., frustration) and cognitive (e.g., effort) responses to the system **All:** Only effective if the communication channel supports the purpose of the meeting

Table 2: Applied constructs of UES in Gather

6 LIMITATIONS AND FUTURE WORK

There is a possibility that participants could have compared their experience with other online communication tools they have used before because this is a study designed between subjects, thus potentially adding a ceiling effect to the UES values from our preliminary results. In channels A and B, participants had access to a virtual space, which means that they could still see the researcher move around to spaces (even with the instructions to stay still). This could have biased their UES scale because they might have rated it with an avatar condition in mind (rather than just specifically audio-only or audio+video).

We acknowledge we did not disaggregate the participants by gender or geographical location, any of which could be useful and pertinent to the experience of their participants because it is extremely difficult to schedule groups of 3 or more participants at different timezone. Further analysis could examine how these factors could affect the experience of genders and social constructs. We disabled white noise (e.g., television static, fireplaces) within our study. Future studies should look into how white noise affects engagement in different communication channels. Furthermore, future work could explore collaboration in different settings, such as game jams or educational settings, using the applied definition of engagement in communication channels to learn more about how engagement differs in different collaborative environments. Future work should study the different stages of collaboration in different types of communication, especially hybrid meetings with people in the same room and others in different places, to see how engagement changes as users switch between the roles of facilitator and listener.

Cultural differences may affect the way people use communication channels and should be investigated. Another great future work possibility is studying how technology helps people get involved in different kinds of communication, especially when they are far away, to find ways that technology can be used to improve engagement and collaboration among participants. Lastly, future studies should focus on the idea of *time* and how collaboration stages vary between each communication modality. We plan to continue to investigate instances when a user changes from a facilitator to a listener, and how engagement varies within hybrid (co-located meetings) meetings.

ACKNOWLEDGMENTS

This work was made possible by the NSERC CREATE SWaGUR grant, Social Sciences and Humanities Research Council, Lennart Nacke's NSERC Discovery Grant, the Canada Foundation for Innovation John R. Evans Leaders Fund "The seamless user-centered conscious experience study system (SUCCESS)". We thank all the participants who participated in our study. Special thanks to Derrick Wang and Dr. Stuart Hallifax for assisting in the study and video work. Thanks to Dr. Neil Randall, Alexander Glover, and Ekaterina Durmanova for being radiant models in the video. Thanks to Charlie (doggo) for being an incredible source of emotional support throughout the writing process. We also thank Gather.Town for allowing us to access their API system.

REFERENCES

[1] David Des Armier Jr, Craig E Shepherd, and Stan Skrabut. 2016. Using game elements to increase student engagement in course assignments. *College Teaching* 64, 2 (2016), 64–72. Publisher: Taylor & Francis.

[2] Steven Baker, Jenny Waycott, Romina Carrasco, Ryan M Kelly, Anthony John Jones, Jack Lilley, Briony Dow, Frances Batchelor, Thuong Hoang, and Frank Vetere. 2021. Avatar-mediated communication in social VR: an in-depth exploration of older adult interaction in an emerging communication platform. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, 1–13. https://doi.org/10.1145/3411764.3445752

[3] Arnold B Bakker, Simon L Albrecht, and Michael P Leiter. 2011. Key questions regarding work engagement. *European journal of work and organizational psychology* 20, 1 (2011), 4–28. Publisher: Taylor & Francis.

[4] Pernille Bjørn, Morten Esbensen, Rasmus Eskild Jensen, and Stina Matthiesen. 2014. Does distance still matter? Revisiting the CSCW fundamentals on distributed collaboration. *ACM Transactions on Computer-Human Interaction (TOCHI)* 21, 5 (2014), 1–26. Publisher: ACM New York, NY, USA.

[5] Anita L Blanchard. 2021. The effects of COVID-19 on virtual working within online groups. *Group Processes & Intergroup Relations* 24, 2 (2021), 290–296. Publisher: SAGE Publications Sage UK: London, England.

[6] Angela Bonifati, Giovanna Guerrini, Carsten Lutz, Wim Martens, Lara Mazilu, Norman W Paton, Marcos Antonio Vaz Salles, Marc H Scholl, and Yongluan Zhou. 2021. Holding a conference online and live due to Covid-19: Experiences and lessons learned from EDBT/ICDT 2020. *ACM SIGMOD Record* 49, 4 (2021), 28–32. Publisher: ACM New York, NY, USA.

[7] Elizabeth Bonsignore, Derek Hansen, Kari Kraus, June Ahn, Amanda Visconti, Ann Fraistat, and Allison Druin. 2012. Alternate Reality Games: platforms for collaborative learning. In *The Future of Learning: Proceedings of the 10th International Conference of the Learning Sciences (ICLS 2012)*, Vol. 1. International Society of the Learning Sciences (ISLS), Sydney, NSW, Australia, 251–258. Publisher: International Society of the Learning Sciences (ISLS).

[8] Nathan Bos, Judy Olson, Darren Gergle, Gary Olson, and Zach Wright. 2002. Effects of four computer-mediated communications channels on trust development. In *Proceedings of the SIGCHI conference on Human factors in computing systems Changing our world, changing ourselves - CHI '02*. ACM Press, Minneapolis, Minnesota, USA, 135. https://doi.org/10.1145/503376.503401

[9] Klaudia Bovermann and Theo J Bastiaens. 2020. Towards a motivational design? Connecting gamification user types and online learning activities. *Research and Practice in Technology Enhanced Learning* 15, 1 (2020), 1–18. Publisher: SpringerOpen.

[10] Virginia Braun and Victoria Clarke. 2021. One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative research in psychology* 18, 3 (2021), 328–352. Publisher: Taylor & Francis.

[11] Tara J Brigham. 2015. An introduction to gamification: adding game elements for engagement. *Medical reference services quarterly* 34, 4 (2015), 471–480. Publisher: Taylor & Francis.

[12] Qidong Cao, Thomas E. Griffin, and Xue Bai. 2009. The importance of synchronous interaction for student satisfaction with course web sites. *Journal of Information Systems Education* 20, 3 (2009), 331.

[13] Kathy Chandler. 2016. Using breakout rooms in synchronous online tutorials. *Journal of Perspectives in Applied Academic Practice* 4, 3 (2016), 16–23.

[14] Chong-Meng Chee and Doris Hooi-Ten Wong. 2017. Affluent gaming experience could fail gamification in education: a review. *IETE Technical Review* 34, 6 (2017), 593–597. Publisher: Taylor & Francis.

[15] Maitraye Das, John Tang, Kathryn E Ringland, and Anne Marie Piper. 2021. Towards accessible remote work: Understanding work-from-home practices of neurodivergent professionals. *Proceedings of the ACM on Human-Computer Interaction* 5, CSCW1 (2021), 1–30. Publisher: ACM New York, NY, USA.

[16] Melissa DeJonckheere and Lisa M Vaughn. 2019. Semistructured interviewing in primary care research: a balance of relationship and rigour. *Family Medicine and Community Health* 7, 2 (2019), 1–8. Publisher: BMJ Publishing Group.

[17] Alan R Dennis and Susan T Kinney. 1998. Testing media richness theory in the new media: The effects of cues, feedback, and task equivocality. *Information systems research* 9, 3 (1998), 256–274. Publisher: INFORMS.

[18] Paul Denny. 2013. The effect of virtual achievements on student engagement. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, 763–772. https://doi.org/10.1145/2470654.2470763

[19] Edgar Erdfelder, Franz Faul, and Axel Buchner. 1996. GPOWER: A general power analysis program. *Behavior research methods, instruments, & computers* 28, 1 (1996), 1–11. Publisher: Springer.

[20] Travis Faas, I-ching Liu, Lynn Dombrowski, and Andrew D Miller. 2019. Jam today, jam tomorrow: Learning in online game jams. *Proceedings of the ACM on Human-Computer Interaction* 3, GROUP (2019), 1–27. Publisher: ACM New York, NY, USA.

[21] Jennifer Fereday and Eimear Muir-Cochrane. 2006. Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *International journal of qualitative methods* 5, 1 (2006), 80–92. Publisher: SAGE Publications Sage CA: Los Angeles, CA.

[22] Jonathan E Finkelstein. 2006. *Learning in real time: Synchronous teaching and learning online*. Vol. 5. John Wiley & Sons, New York, NY, USA.

[23] Robert S. Fish, Robert E. Kraut, Robert W. Root, and Ronald E. Rice. 1992. Evaluating video as a technology for informal communication. In *Proceedings of the SIGCHI conference on Human factors in computing systems*. Association for Computing Machinery, New York, NY, USA, 37–48. https://doi.org/10.1145/142750.142755

[24] Fortes Tondello, Gustavo. 2019. *Dynamic Personalization of Gameful Interactive Systems*. PhD Thesis. UWSpace. http://hdl.handle.net/10012/14807

[25] Jesse Fox, Jeremy N Bailenson, and Liz Tricase. 2013. The embodiment of sexualized virtual selves: The Proteus effect and experiences of self-objectification via avatars. *Computers in Human Behavior* 29, 3 (2013), 930–938. Publisher: Elsevier.

[26] James Paul Gee. 2005. Pleasure, learning, video games, and life: The projective stance. *E-Learning and Digital Media* 2, 3 (2005), 211–223. Publisher: SAGE Publications Sage UK: London, England.

[27] James Paul Gee. 2008. Video games and embodiment. *Games and culture* 3, 3-4 (2008), 253–263. Publisher: SAGE Publications Sage CA: Los Angeles, CA.

[28] Carl Gutwin, Saul Greenberg, Roger Blum, Jeff Dyck, Kimberly Tee, and Gregor McEwan. 2008. Supporting Informal Collaboration in Shared-Workspace Groupware. *J. Univers. Comput. Sci.* 14, 9 (2008), 1411–1434.

[29] Susan C. Herring and Sharon Stoerger. 2014. Gender and (a) nonymity in computer-mediated communication. *The handbook of language, gender, and sexuality* 2 (2014), 567–586. Publisher: John Wiley & Sons Hoboken, NJ.

[30] Ivo van Hilvoorde and Niek Pot. 2016. Embodiment and fundamental motor skills in eSports. *Sport, Ethics and Philosophy* 10, 1 (2016), 14–27. Publisher: Taylor & Francis.

[31] Seung-A. Annie Jin. 2011. "It feels right. Therefore, I feel present and enjoy": The effects of regulatory fit and the mediating roles of social presence and self-presence in avatar-based 3D virtual environments. *Presence: Teleoperators and Virtual Environments* 20, 2 (2011), 105–116. ISBN: 1054-7460 Publisher: MIT Press One Rogers Street, Cambridge, MA 02142-1209, USA journals-info ....

[32] Karl M Kapp. 2012. *The gamification of learning and instruction: game-based methods and strategies for training and education*. John Wiley & Sons, San Francisco.

[33] Hiroki Kashiwazaki, Takuro Ozaki, Hajime Shimada, Yusuke Komiya, Eisaku Sakane, Kazuhiro Mishima, Shiu Sakashita, Nariyoshi Yamai, Yoshiaki Kitaguchi, and Kensuke Miyashita. 2021. Japanese activities to bring online academic meetings against COVID-19: How we learned to stop worrying and love the online meetings. In *ACM SIGUCCS Annual Conference*. Association for Computing Machinery, New York, NY, USA, 54–59.

[34] Husni Kharouf, Rui Biscaia, Alexeis Garcia-Perez, and Ellie Hickman. 2020. Understanding online event experience: The importance of communication, engagement and interaction. *Journal of Business Research* 121 (2020), 735–746. Publisher: Elsevier.

[35] Tae Kyun Kim. 2017. Understanding one-way ANOVA using conceptual figures. *Korean journal of anesthesiology* 70, 1 (2017), 22–26. Publisher: The Korean Society of Anesthesiologists.

[36] Rune Klevjer. 2006. *What is the avatar? Fiction and embodiment in avatar-based singleplayer computer games*. Ph.D. Dissertation. University of Bergen. Publisher: The University of Bergen.

[37] Celine Latulipe, N Bruce Long, and Carlos E Seminario. 2015. Structuring flipped classes with lightweight teams and gamification. In *Proceedings of the 46th ACM Technical Symposium on Computer Science Education*. Association for Computing Machinery, New York, NY, USA, 392–397. https://doi.org/10.1145/2676723.2677240

[38] Celine Latulipe and Deborah Turnbull Tillman. 2022. Curating Interactive Art for Online Conferences: Artist, Curator and Technologist Experiences in Gather. Town. In *Creativity and Cognition*. Association for Computing Machinery, New York, NY, USA, 380–391. https://doi.org/10.1145/3527927.3532811

[39] Rui Leitão, Martin Maguire, Sarah Turner, and Laura Guimarães. 2022. A systematic evaluation of game elements effects on students' motivation. *Education and Information Technologies* 27, 1 (2022), 1081–1103. Publisher: Springer.

[40] Lingyuan Li, Divine Maloney, and Guo Freeman. 2021. Collaboration, Dedication, and Social Pressure: A Comparative Analysis of Virtual and Face-to-Face Game Jams. In *Proceedings of the Annual Hawaii International Conference on System Sciences*. IEEE, HI, USA, 10.

[41] Mengxiang Li, Qiqi Jiang, Chuan-Hoo Tan, and Kwok-Kee Wei. 2014. Enhancing user-game engagement through software gaming elements. *Journal of Management Information Systems* 30, 4 (2014), 115–150. Publisher: Taylor & Francis.

[42] Elisa D Mekler, Florian Brühlmann, Klaus Opwis, and Alexandre N Tuch. 2013. Do points, levels and leaderboards harm intrinsic motivation? An empirical analysis of common gamification elements. In *Proceedings of the First International Conference on gameful design, research, and applications*. Association for Computing Machinery, New York, NY, USA, 66–73.

[43] Sarah Morrison-Smith and Jaime Ruiz. 2020. Challenges and barriers in virtual teams: a literature review. *SN Applied Sciences* 2, 6 (2020), 1–33. Publisher: Springer.

[44] Momoko Nakatani, Yoko Ishii, Ai Nakane, Chihiro Takayama, and Fumiya Akasaka. 2021. Improving Satisfaction in Group Dialogue: A Comparative Study of Face-to-Face and Online Meetings. In *International Conference on Human-Computer Interaction*. Springer-Verlag, Berlin, Heidelberg, 598–610.

[45] Christa R Nevin, Andrew O Westfall, J Martin Rodriguez, Donald M Dempsey, Andrea Cherrington, Brita Roy, Mukesh Patel, and James H Willig. 2014. Gamification as a tool for enhancing graduate medical education. *Postgraduate medical journal* 90, 1070 (2014), 685–693. Publisher: The Fellowship of Postgraduate Medicine.

[46] Cindy Norris and James B. Fenwick. 2022. Experiences with online education during COVID-19. In *Proceedings of the ACM Southeast Conference*. ACM, Virtual Event, 44–51. https://doi.org/10.1145/3476883.3524049

[47] Kristine L Nowak and Jesse Fox. 2018. Avatars and computer-mediated communication: a review of the definitions, uses, and effects of digital representations. *Review of Communication Research* 6 (2018), 30–53. Publisher: ESP.

[48] Catherine S Oh, Jeremy N Bailenson, and Gregory F Welch. 2018. A systematic review of social presence: Definition, antecedents, and implications. *Frontiers in Robotics and AI* 5 (2018), 114. Publisher: Frontiers.

[49] Heather O'Brien. 2016. Theoretical perspectives on user engagement. In *Why engagement matters*. Springer, New York City, 1–26.

[50] Heather L. O'Brien, Paul Cairns, and Mark Hall. 2018. A practical approach to measuring user engagement with the refined user engagement scale (UES) and new UES short form. *International Journal of Human-Computer Studies* 112 (April 2018), 28–39. https://doi.org/10.1016/j.ijhcs.2018.01.004

[51] Ragesh Raju, Sathyendra Bhat, Shreeranga Bhat, Rio D'Souza, and Athokpam Bikramjit Singh. 2021. Effective usage of gamification techniques to boost student engagement. *Journal of Engineering Education Transformations* 34 (2021), 713–717.

[52] Rabindra Ratan. 2013. Self-presence, explicated: Body, emotion, and identity extension into the virtual self. In *Handbook of research on technoself: Identity in a technological society*. IGI Global, Pennsylvania, United States, 322–336.

[53] Rabindra Ratan, David Beyea, Benjamin J. Li, and Luis Graciano. 2020. Avatar characteristics induce users' behavioral conformity with small-to-medium effect sizes: A meta-analysis of the proteus effect. *Media Psychology* 23, 5 (2020), 651–675. ISBN: 1521-3269 Publisher: Taylor & Francis.

[54] Ulrike Schultze. 2010. Embodiment and presence in virtual worlds: a review. *Journal of Information Technology* 25, 4 (2010), 434–449. Publisher: Springer.

[55] Kimberly Tee, Saul Greenberg, and Carl Gutwin. 2006. Providing artifact awareness to a distributed group through screen sharing. In *Proceedings of the 2006 20th Anniversary Conference on Computer Supported Cooperative Work*. Association for Computing Machinery, New York, NY, USA, 99–108. https://doi.org/10.1145/1180875.1180891

[56] Joseph B Walther. 1996. Computer-mediated communication: Impersonal, interpersonal, and hyperpersonal interaction. *Communication research* 23, 1 (1996), 3–43. Publisher: Sage Publications London.

[57] Joseph B Walther. 2011. Theories of computer-mediated communication and interpersonal relations. *The handbook of interpersonal communication* 4 (2011), 443–479.

[58] Bin Wang, Yukun Liu, Jing Qian, and Sharon K Parker. 2021. Achieving effective remote working during the COVID-19 pandemic: A work design perspective. *Applied psychology* 70, 1 (2021), 16–59. Publisher: Wiley Online Library.

[59] Eric N Wiebe, Allison Lamb, Megan Hardy, and David Sharek. 2014. Measuring engagement in video game-based environments: Investigation of the User Engagement Scale. *Computers in Human Behavior* 32 (2014), 123–132. Publisher: Elsevier.

[60] Bradley E Wiggins. 2016. An overview and study on the use of games, simulations, and gamification in higher education. *International Journal of Game-Based Learning (IJGBL)* 6, 1 (2016), 18–29. Publisher: IGI Global.

[61] Nick Yee, Jeremy N Bailenson, and Nicolas Ducheneaut. 2009. The Proteus effect: Implications of transformed digital self-representation on online and offline behavior. *Communication Research* 36, 2 (2009), 285–312. Publisher: Sage Publications Sage CA: Los Angeles, CA.

[62] Xin Zhao and Colin Derek McClure. 2022. Gather. Town: A Gamification Tool to Promote Engagement and Establish Online Learning Communities for Language Learners. *RELC Journal* 1 (2022), 00336882221097216. https://doi.org/10.1177/00336882221097216 Publisher: SAGE Publications Sage UK: London, England.

Received 2023-06-22; accepted 2023-08-03