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Marianne Mäntyoja & Johanna Hautala

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Possibilities and limitations of learning in Zoom, on campus, and in VR – students' experiences of hybrid learning spaces

Marianne Mäntyoja and Johanna Hautala

School of Management, University of Vaasa, Vaasa, Finland

ABSTRACT

This article addresses the need for empirical research comparing students' experiences of learning in different hybrid spaces in higher education that blend digital spaces, physical spaces and learning interactions. We focus on hybrid spaces formed around Zoom, non-immersive virtual reality (VR), and on-campus with a telepresence robot (TPR) tested on a course in Regional Studiemitations of hybrid spaces for collaborative learning, knowledge sharing, and group-based communication. Based on four student surveys and instructor's diary along the course, we discuss possibilities and limitations of hybrid spaces of Home/Zoom, Actual/Virtual Reality, and Classroom/TPR. Even though students consider f2f on-campus meeting support collaborative learning best, they need place-flexible learning possibilities and are curious for new technologies and hybrid learning spaces. We advance theorization of hybrid learning space through identifying a posthuman learner, a human through, for instance, an avatar or TPR, that is required to enter, interact and learn in hybrid spaces.

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Face-to-face interaction; hybrid learning space; telepresence robot; virtual reality (VR); Zoom; tacit knowledge

Introduction

In the post-COVID-19-era, higher education of geography is increasingly taking place in place-flexible and remote settings, which requires technologies to mediate collaborative learning, knowledge sharing, and interaction (Mercer et al., 2023; West et al., 2024). New communication technologies include video meetings entered through video screens in Zoom, virtual realities experienced through virtual avatars, and physical spaces where one can participate remotely via a (semi-autonomous) telepresence robot (TPR) with wheels and a screen display that can be controlled with a smartphone or a PC (Perifanou et al., 2022, p. 1). Thus, the agency of a learner to learn is "always already co-constituted with technologies" (Rose, 2017, p. 779). When technology enters a space, it creates a hybrid learning space that blend together physical spaces, digital spaces and learning interactions (Trentin, 2015).

Practical and theoretical skills related to these technologies are important for geographers, their education, and advancing the pedagogy of geography in the

CONTACT Marianne Mäntyoja marianne.mantyoja@uwasa.fi School of Management, University of Vaasa, Wolffintie 32, Vaasa 65101, Finland

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digital age for three key reasons. First, geographers frequently engage in tasks that require the dissemination and generation of knowledge within global teams, projects and networks, and apply expertise that is not available locally. Examples include developing more peripheral or remote regions outside core cities or contributing locally to tackle global climate change. In this context, the ability to communicate and collaborate effectively in hybrid learning environments becomes a key skill. Second, universities located outside major cities or during pandemics must offer place-flexible, accessible education to geographically dispersed groups of students, facilitating high quality, collaborative learning experiences. For example, in Finland, geography students may not stay in their university city for the whole education period, but may relocate for various reasons, such as employment opportunities. For these students, technology-mediated communication allows participation from everywhere and caters for diverse needs and preferences (Burnett, 2024).

Third, geography as a discipline is undergoing a "digital turn", which has reshaped "the production and experience of space", and affected both the geographical theory and praxis (Ash et al., 2018, p. 35). Research on hybrid learning spaces contributes to discussing the "digital turn" in geographical pedagogy and in the Journal of Geography in Higher Education, where the digital turn is little referred to (except for: Davies et al. (2019); Marcus (2023); Waite (2024). Developing best pedagogical methods and practices requires knowledge of students' interaction with digital interfaces and their experiences of hybrid learning spaces through embodied, emotional and affective practices (Liu, 2024, p. 5).

We address the need for empirical research comparing students' experiences of learning in various hybrid spaces in higher education. We focus on hybrid spaces formed around Zoom, a classroom (with one instructor on-site and another as a TPR), and non-immersive VR (i.e. desktop VR). We conceive of such environments as hybrid learning spaces and advance the concept through the posthuman approach to the learner who enters, discusses, and learns in these spaces as a partly technological being (e.g. a virtual avatar) (see Alaimo, 2010; Hayles, 2017; Rose, 2017). We present a study conducted during a regional studies course at the University of Vaasa (2023). We aim to understand the possibilities and limitations of hybrid spaces for a collaborative learning process in higher education. We ask the following: (1) How do students experience Zoom, on-campus, and VR support and limit knowledge sharing, learning, and group-based communication; and (2) Do students perceive differences between Zoom, on-campus, and VR learning in their opportunities to support knowledge sharing, learning, and group-based communication? The study is based on two empirical materials. Primarily, a survey was repeated four times: after meetings via Zoom, on campus and VR, and a final survey at the end of the course ($N = 19–27$, 70–100% of the course attendees). Supplementing data include observations in the instructor's diary of being in and constructing the learning spaces.

As key results, we present students' learning experiences in home/Zoom, classroom/TPR, and actual/virtual reality. These hybrid spaces blend digital, physical, and social spaces that create supporting and distracting elements for learning. For example, when off campus, the physical space where the student or the instructor is located can distract interactive learning. Moreover, students and instructors participate in the hybrid

learning spaces as posthuman learners with particular communicative abilities and limitations: humans through avatars, robots, or Zoom screens. Students observe that f2f is best in supporting learning, sharing tacit knowledge, and socializing into the student community, and they prefer "human" instructors over TPRs and avatars.

Learning and sharing (tacit) knowledge in hybrid learning spaces

In this article, we consider learning from a social constructionist perspective as an interactive and social process in groups and communities (Berger & Luckmann, 1966; Wenger, 1998). Learning takes place by sharing, creating, and internalizing (i.e. interpreting) knowledge and is the "result of the interaction between people and the environment" (Herrera-Pavo, 2021, p. 1). Considering learning through knowledge is particularly important in higher education where the purpose is to create academic knowledge (i.e. new, systematically researched and critically justified outcomes) (Hautala & Jauhiainen, 2014). University students learn new knowledge by interacting with their peers and instructors – be it in writing, talking, or doing – and then interpreting such interactions into their knowledge.

Knowledge is *partly* tacit: embedded in our discipline-specific practices and wider frameworks of thinking and embodied in our skills and experiences. We expressed "partly tacit" because we consider different elements to intertwine into knowledge that is an entity "inscribed in bodily skills and embedded in sociomaterial practices" (Dreyfus, 2014, 2017; Hadjimichael & Tsoukas, 2019, p. 673; Sandberg & Tsoukas, 2011). Thus, tacit knowledge elements exist in relation to explicit ones that can be expressed in texts, models, and codes, and thus are easy to transfer via email or a phone conversation, for example. On the contrary, tacit knowledge elements are "difficult to have consciousness of, or express in language" (Hadjimichael & Tsoukas, 2019, p. 673; Polanyi, 1958, 1966). Empirical research has shown that tacit knowledge elements are best shared in f2f interaction, socializing into communities and their practices, and engaging one's body into learning-by-doing (Kuebart & Ibert, 2020; Nonaka & Takeuchi, 1995).

Learning new knowledge and sharing knowledge are spatial phenomena Grabher and Ibert (2014); Meusburger and Werlen (2017) and today's learning spaces have become increasingly technological. Over time, the concept of hybrid has evolved to include at least three interpretations (Eyal & Gil, 2022). First, hybrid was seen as a synonym for "blended," an intermix of traditional and online methods. The hybrid as blended approach focuses on the location of the learner either in a classroom or in an online environment (Eyal & Gil, 2022, pp. 12–15). Second, hybrid "as a space of merging interactions" merge physical spaces, digital spaces and learning interactions (Trentin, 2015). This draws attention to the learning environment rather than to the location of the learner. The state of constant connection to the internet and other users through mobile devices adds a social dimension to the meaning of hybrid (Eyal & Gil, 2022, pp. 15–16). Third, hybrid as "fluid" emphasizes learners' choice and motivation as they move without traditional constraints (i.e. place, time, and budget) across boundaries (Eyal & Gil, 2022, pp. 18–19). Autonomous students decide what, when, and how to study, which develops their identity and advances their learning (Eyal & Gil, 2022, p. 20).

However, in hybrid learning spaces, agency to learn is not solely human, but "always already coconstituted with technologies" (Rose, 2017, p. 779; see also

Herbrechter, 2018a), hybridized with technologies (Adams & Jansson, 2023), and shaped by non-human elements (Charteris & Smardon, 2018, pp. 60–62). Such agency is defined by the ability to engage in purposeful actions, movements, and decisions that are oriented at learning, sharing and acquiring knowledge within the context of learning processes (Burnett, 2024, pp. 495–496; Harris & Rousell, 2022, p. 428). It emerges through the entanglements of human and non-human actors, including digital interfaces, virtual environments and embodied representation of learners and instructors (Alaimo, 2010; K, 2017). The posthuman approach considers learning agency as co-constituted with technologies. It implies decentering of the human subject, acknowledging the role of both human and nonhuman elements involved in creating (or disrupting) the learning experience (Herbrechter, 2018b). In this study, the posthuman approach is relevant in recognizing that students and instructors enter, interact with, and learn in the hybrid learning spaces not only through their own bodies but also through Zoom screens, TPRs and virtual avatars. The ability to learn, share, and acquire knowledge in hybrid learning spaces is contingent upon the abilities to act and communicate through the human-technology representation of learners and instructors.

Possibilities and limitations of Zoom, TPRs and VR for learning

After the COVID-19 pandemic, more research concerning remote learning technologies has been published in higher education journals (see, e.g. Mercer et al., 2023; Ramoroka et al., 2023). Despite this, few studies about remote learning during the pandemic have addressed students' experiences (West et al., 2024). Considering the technologies addressed in this article, most publications have focused on Zoom and VR but only a few on TPRs (e.g. De Jong, 2021). Importantly, we could not find any publications that would include all three technologies or compare Zoom, VR, and on-campus settings for interactive learning. Next, we summarize what current research has found about the possibilities and limitations of each technology to learning in higher education.

The benefits of Zoom for learning include flexibility (Serhan, 2020, p. 339), ease of use, reliability (Ramoroka et al., 2023, p. 105), and breakout rooms that are collaborative workspaces where students can interact with peers and work on group projects (Romero-Ivanova et al., 2020, p. 85). Limitations include distractions in the place the student is attending the class (Ramoroka et al., 2023, p. 339), lack of social and facial cues, and feelings of isolation from both peers and instructors (Ramoroka et al., 2023). Students have expressed a preference towards traditional f2f learning methods over online learning in general (Ritonga et al., 2021). In terms of motivation, level of participation, and attention to the class tasks, students prefer f2f interaction over Zoom (Serhan, 2020, p. 338).

TPRs' possibilities for learning largely relate to their ability to move in the classroom in order to interact with one or more persons (Perifanou et al., 2022, p. 2). However, moving the TPR can be difficult and may require assistance, especially if there are too many obstacles in the physical space, such as chairs, lifts, and doors (Perifanou et al., 2022, pp. 4–5). Also, considerations must be made to find the optimal room placement for the robot so that the user can see and hear everything (De Jong, 2021, pp. 152–153). Students who were in a classroom with a TPR reported difficulties interacting with the

TPR user, for example, due to technical hearing issues and difficulties picking up visual or verbal cues to know when to speak or ask questions (De Jong, 2021, pp. 152–153). Moreover, on-site peers might forget or ignore the TPR user as they were not present in person in the classroom (De Jong, 2021, p. 153).

Some of the possible concerns and problems raised by students associated with immersive VR adoption included the cost, health issues such as motion sickness, and complexity of the hardware leading to potential distractions (Baxter & Hainey, 2019), which can be avoided by adopting non-immersive VR. However, the feeling of presence and, therefore, engagement and transfer of learning are lower in non-immersive VR (Freina & Canessa, 2015). Further suitability of non-immersive VR for collaborative learning has not been examined in detail. In the case of immersive VR, students estimated that it supported collaborative learning as the fourth-best pedagogical approach after experiential, active, and problem-based learning (Baxter & Hainey, 2019).

Materials and methods

We conducted the empirical study in fall 2023 from a 5 ETCS regional studies course completed by 27 students at the University of Vaasa. The learning goals included theoretical understanding of geographies of innovations and knowledge-based economies, and practical skills to support regional development through global innovation processes, which experimenting learning in different hybrid spaces facilitated.

The course consisted of five instructor-led meetings, four independently written essays after each of the four first instructor-led meetings, and four student group meetings for deepening knowledge on the topics of the instructor-led meetings and essays (Figure 1). In addition to instructor-led meetings, the students were given the decision to organize their student group meetings in Zoom, VR or in person. The course started with two Zoom meetings and in the fourth instructor-led meeting a TPR was presented in the classroom. The fourth instructor-led meeting was organized in VR. Non-immersive VR was chosen because of its benefits compared to high-immersive VR via head-mounted-display (HMD) such as accessibility and low cost (see e.Baxter and Hainey (2019); Burnett (2024). Non-immersive VR gathered the students to synchronously learn in one place through only their own devices (desktop PC or laptop) from any location. The decision to employ non-immersive VR imposes certain limitations on the study. For example, the design of the hardware affects the level of bodily presence, intensity of bodily sensations, and the ability to sense others and space. Therefore, the utilization of

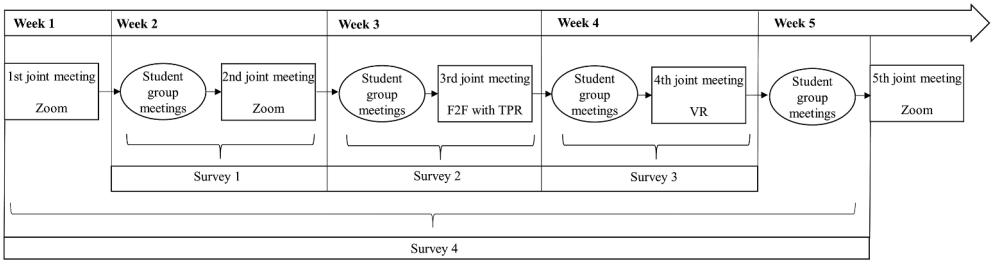

Figure 1. Course structure, meetings and surveys.

HDMs may influence the level and intensity of collaborative learning and tacit knowledge sharing. We acknowledge such limitations when generalizing the results to high-immersion VR contexts.

We collected two different empirical materials from the course. The primary materials include repeated surveys for the students, and the secondary material includes a diary of the instructor where she describes her experiences of using technologies and interacting with the students. We analysed the students' experiences of learning via three surveys collected after meetings via Zoom ($N = 27$), on campus with a TPR ($N = 20$), and in VR ($N = 20$), as well as a summarizing survey at the end of the course ($N = 19$). Descriptive information of the respondents is displayed in Table 1.

The University of Vaasa granted a research permit for the study, which required a clearance and evaluation of the ethical issues related to the study. The students were carefully informed about the research project, given the privacy notice, guaranteed anonymity, and informed that answering the surveys is voluntary and will not affect their course evaluation. In each survey, the participants gave their consent to participate in the study by confirming that they understand the goals of the research and approve that the survey answers can be used in the research project and are stored according to the data-protection regulation.

Surveys 1–3 included the following sections: background, perceived ability of the meeting space to support learning, current state of learning in comparison to the learning objectives of the course (self-evaluation), and sense of presence felt in the course meeting. In survey 4, we asked the students to summarize their experiences. We asked about their preferences in terms of meeting spaces and forms as either humans or technological beings and the perceived abilities to create and share knowledge as humans and technological beings. The questions included single-choice, multiple-choice, and Likert-style (1 = very poorly . . . 4 = very well) questions, as well as open-ended questions.

To make sure that the respondents understood the most difficult concepts (i.e. "tacit knowledge" and "sense of presence"), we provided clarifying explanations in the surveys. Tacit knowledge was described as "e.g., embodied (swimming, body language etc.), socialization into a group, sensing the atmosphere, or secrets." Tacit knowledge was also discussed in the instructor-led meeting prior to answering surveys. We described

Table 1. Participant characteristics.

Variable	Response option	N
Gender	Male	12
	Female	15
	Other	0
Degree program	Bachelor's degree	9
	Master's degree	14
Field of study	Administrative sciences	10
	Business studies	12
Number of ECTS completed	0–60	8
	61–120	5
	121–180	3
	181–240	10
	241–300	1
Confidence in using technology	Not very confident	1
	I feel OK with it	8
	I am quite confident using IT	16
	I am highly confident with IT	2

sense of presence as "i.e., 'being there' with others, and ability to use all senses for experiencing others and space."

Considering the research task, we decided that both qualitative and quantitative data were needed to get a comprehensive view on people's personal experiences of the topic. The first phase of the data analysis focused on the qualitative findings. Insights to answer research question 1 are mainly drawn from the open-ended questions in surveys 1–3 about how the students evaluated each hybrid space to supported and prevented learning, as well as what kind of sense of presence they experienced. These are complimented by answers to the open-ended questions in the summarizing survey, survey 4, as well as descriptive quantitative data. To answer research question 2, we analysed the descriptive quantitative data using a nonparametric Friedman test to analyse whether there are statistically proven differences between Zoom, on-campus, and VR instruction in terms of the students' perceptions on their ability to support learning. To determine whether the differences detected are statistically significant, we used the Bonferroni corrected significance level (P-value, interpreted as significant $p < 0.05$) for multiple comparisons of 0.05. We chose the Friedman test because it is an appropriate statistical test to analyse small data sets of ordinal-level data from a repeated measurement research design (Sheldon et al., 1996, p. 227).

Students' perception of learning and sharing knowledge in hybrid learning spaces

We start by answering the following: How do students experience Zoom, on-campus, and VR support and limit knowledge sharing, learning, and group-based communication? According to the results, the hybrid and blended nature of learning spaces were key to understanding students' learning experiences. Thus, we discuss our results under three hybrid learning spaces: home/Zoom, classroom/TPR, and actual/virtual reality.

Home/Zoom

The first two joint meetings of the course were held via Zoom. The students' responses to the open-ended questions describe a hybrid learning space where the environment of their body – in many cases, home – merge with the digital space of the Zoom meeting. We call this home/Zoom.

Students are used to using Zoom and find it easy to use; only one reported technical difficulties. Zoom supported students' learning either well (58%) or very well (42%). The answers to the open-ended questions support earlier research suggesting that Zoom advances learning through its flexibility (e.g. Serhan, 2020). Zoom also provides equal opportunities to learn despite location.

> it's easy to use and you learn a lot with it (I felt very comfortable using this platform) (Survey 1)

> Zoom gave me flexibility to not physically be in Vaasa, but I had the same chance to learn as everybody else. (Survey 1)

The instructor also wrote about the simplicity of Zoom when compared to the anxiety she felt with VR and TPR:

> It would be so much easier to just meet in Zoom. Everybody knows how to use that. I could concentrate only on the contents of what I teach, and how I teach, and not to worry about technology. (Diary 11.9.2023)

All students reported they understood knowledge shared via Zoom either well (68%) or very well (32%). A clear majority (76%) estimated that Zoom allows sharing tacit and embodied knowledge well (64%) or very well (12%), whereas 24% answered poorly." However, regarding socialization, the students' answers were divided. Over half (58%) estimated that Zoom encouraged socialization into the student community well (50%) or very well (8%), whereas the rest (43%) argued "poorly" (35%) or "very poorly" (8%). The following quotes describe the experience of socializing, being part of the course-related community, and sensing the atmosphere on Zoom:

> I first felt a little bit nervous to meet via Zoom because most of the other students were new faces and the topic was totally new to me, but after 10 minutes, I felt more relaxed, and it was easy to be part of this lecture. Also, I could feel the tension of the others in general, but it got easier during the lecture, the atmosphere was more relaxed, and it was easier to communicate. (Survey 1)

> While peers are farther away, teacher(s) are easier to access, and it is easier to follow the lecture on the same level (or even easier) than in the F2F meeting. (Survey 1)

Zoom hinders learning through distraction in the physical space (Ramoroka et al., 2023, p. 107; Serhan, 2020, pp. 339–340). One student reported attending the class from their home with shared living arrangements with other people whose movements distracted their focus. More often, however, the students expressed that Zoom allowed them to engage in other activities at home during a lecture (e.g. household chores).

> I was sometimes distracted when I started to do dishes etc. (Survey 1)

> I moved from my desk to my bed and got sleepy but that was my own fault. (Survey 1)

Several students expressed a higher threshold to participate in interactions via Zoom. A microphone as a technical feature and the Zoom screen focusing on the person talking provide the cue that only one person should be talking at a time. These features disrupt the natural rhythm of conversation and possibly exclude some of the verbal and visual feedback, such as small comments, gestures, and body language. Thus, students may feel more distance between them and their peers.

> Sometimes it's harder to talk with others when you need you unmute/mute and everyone does not have their camera on. (Survey 1)

> Sometimes, knowing that everyone is paying all their attention to me when I am speaking makes me a little bit anxious. (Survey 1)

Classroom/TPR

The third meeting of the course was organized in a classroom, on campus, in Vaasa. Although the students and the instructor were present in the classroom, we invited a visiting lecturer into the meeting through a TPR that the students had named "Kepakko" (in English, "Sticky"). Therefore, a combination of on-site presence and telepresence created the hybrid space of classroom/TPR.

For the students, this meeting was primarily f2f communication with other students and the instructor, which they felt adequately supported knowledge sharing, learning, and collaboration. All except one of the respondents reported that f2f interaction supported their learning either well (45%) or very well (55%). Their descriptions suggest better (sensory) focus through seeing and listening:

> It was easier to stay focused than in zoom. (Survey 2)

> It's always nice to listen to others in the classroom, although it can sometimes be a bit hard to get yourself to the campus. (Survey 2)

All but one reported they understood knowledge shared f2f well (55%) or very well (40%). The few examples of how learning was distracted in the meeting included difficulties of hearing and seeing in some parts of the classroom. Furthermore, 9 out of 10 students (90%) considered that f2f allows for the allocation of tacit and embodied knowledge well (60%) or very well (30%), whereas 10% answered "poorly." All students estimated that f2f promotes socialization with peers well (55%) or very well (45%).

After the f2f lecture, the visiting lecturer gave their presentation as a TPR (Figure 2). All reported that the robot supported their learning either well (65%) or very well (35%). All but one considered they understood knowledge shared either well (45%) or very well (50%). Nine out of 10 (90%) considered that the instructor could share tacit and embodied knowledge as a robot well (65%) or very well (25%). Only 10% answered "poorly" (5%) or "very poorly" (5%).

In the later part of her presentation, the visiting lecturer led a small-group discussion task. She moved around the classroom as a TPR and conversed briefly with the groups. However, contrary to a study by De Jong (2021, p. 156), the students participating in our study did not feel comfortable interacting with the robot. Communication with the TPR was described as "weird" and "odd." This may be because the students were interacting with a TPR for the first time, but, in addition, this was their first time interacting with the

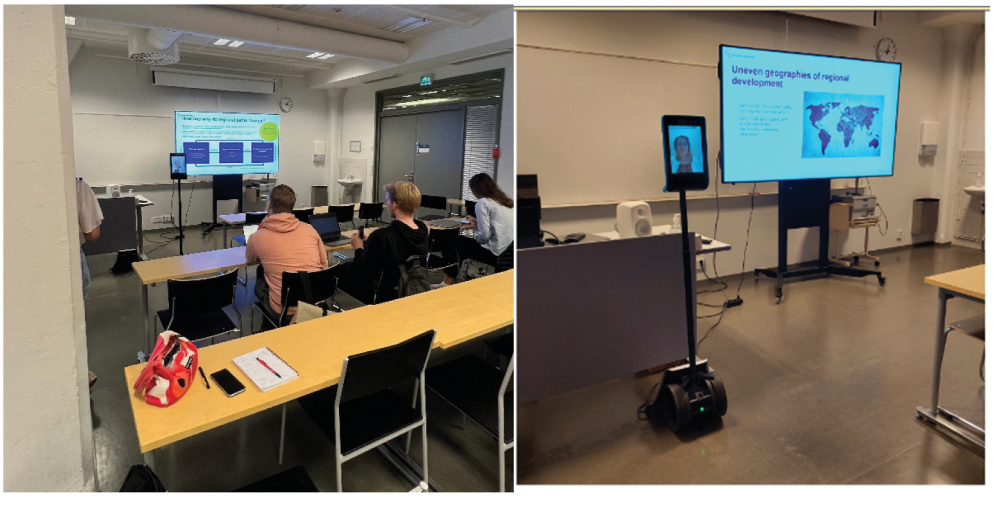

Figure 2. Telepresence robot in the classroom.

visiting lecturer. Other answers report unnamed barriers to communication and troubles relating to the TPR.

> The robot practically could not participate in group discussions. (Survey 4)

> Robots (at least for now) are too far from human to be believable. (Survey 4)

> Human and avatar forms are more familiar, so they are easier for me. The robot was kind of odd and unfamiliar. It would require more getting used to. (Survey 4)

> The easiest way to learn and follow teaching is when the instructor is a human. You are better focused on what she/he says, and it's easy to ask in case something is unclear. As an avatar, you can follow the avatar's body language, which I prefer more compared to a robot that is only a moving screen. (Survey 4)

The instructor's diary entries described the anxiety and technical difficulties experienced as well as how the physical (e.g. rain, robot's weight, distance, tables, chairs of the classroom) and digital (e.g. Wi-Fi connection, robot) spaces blend in forming the hybrid learning space.

> (The lecturer) will be today joining our course through Kepakko. It would be so much easier if she came in person. She would walk herself into the building, call if she needs help, walk easily among students and table rows, switch the PP slides at the right time. [. . .] I had a nightmare about the robot. I am very nervous if it works or not. (Instructor, diary, 11.09.2023, before the meeting)

> I had to take Kepakko to another building across our campus, and it was raining that day. The robot cannot take rain at all. [. . .] Kepakko is heavy. I carry it on my shoulder, and my shoulder starts hurting about halfway there. When I lowered Kepakko down, I realized it is not in range of Wi-Fi anymore. It cannot connect there automatically . . . which is frustrating [. . .] (Instructor, diary, 11.09.2023, after the meeting)

> We were just discussing how to organize the tables in the class so that (the lecturer) could move. My co-teacher said it is funny; we must consider the accessibility from a robot perspective. (Instructor, diary, 11.09.2023, after the meeting)

Actual/virtual reality

The fourth course meeting took place in a non-immersive VR setting designed for meetings of remote team members. This VR can be accessed with a 3D headset, which none of our students had, so they entered the non-immersive (2D) space via their computers. The meeting was held in a mountain landscape with an amphitheatre for presentations and other spaces for group discussions (Figure 3).

VR technology formed a hybrid learning space in two ways: by blending a human with an avatar (and human abilities in actual reality with the avatar's abilities in VR) and through physical – technical realities in the real world that can affect the learning experience. The instructor's diary described the hybrid space of actual and virtual realities, along with the anxiety that use of this technology created. The night before the meeting, the fall's worst storm occurred, which caused extra worry and "bad news for our Wi-Fi connection" (Instructor, diary, 20 September 2023). In addition, the instructor had the flu, which caused her to question how she could lead the meeting as the "hybrid" version of herself and the avatar:

Figure 3. Students and the instructor as avatars in VR at the beginning of the meeting.

> I started thinking about my "being there" as an avatar in (VR). [. . .] (The avatar) cannot continue my presentation if I start coughing. It is completely up to me and my human body. (Instructor, diary, 20.09.2023, before the meeting)

The meeting required advanced preparation among the instructor and students. The students downloaded the software on their computers, customized their avatars, and went through a tutorial in advance. The platform provides a standard-looking avatar whose appearance can be customized down to the finest details, including hair and skin colour, hair style, facial features, outfit, and the style and colour of various accessories. Several similar-looking avatars attended the meeting. On the one hand, some students did not want to dedicate time to customizing their avatars. On the other hand, previous research has shown that people tend to customize avatars to look like themselves (Jauhiainen, 2021, p. 13).

Most students had not been in VR before. At the beginning of the meeting, we had an additional instructor who guided everyone on how to move the avatars and use the space. Thus, latecomers had difficulties moving their avatars and finding the amphitheatre. For example, without gravity, an avatar needed to be brought to the "ground" from the sky. In such moments, the blendedness of actual and virtual was realized: people mimic behaviour that works in actual space, which does not necessarily work in virtual space.

> One student came late. S/he was [. . .] trying to come down to [. . .] the amphitheatre [. . .] It was quite funny [. . .] some students were flying in the air. I flew to him (or her?) and said how to do that. (Instructor, diary, 20.09.2023, after the meeting)

The survey results demonstrate divided views of learning in an actual/virtual hybrid learning space. The majority (60%) considered VR supported their learning poorly (40%) or very poorly (20%). Students without powerful-enough computers reported audio problems (e.g. echoing sound) and interruptions such as having to reconnect due to freezing audio and visuals. Others were able to handle the technology and thought the meeting supported their learning well (25%) or very well (15%). Their descriptions revealed that learning to use VR was new, fun, and interesting, even so that they were

distracted from learning by wandering the space. Some were unsure about the benefits of VR compared to Zoom.

> Since it was the first time for me being in VR, my focus was on other things than learning. For example, how can I move and overall observe the environment? However, I preferred talking in VR compared to Zoom or a classroom. (Survey 3)

> With the computer, I did not find it that much different than a Zoom meeting, but I think it was still quite fun. (Survey 3)

> Definitely interesting, but I find it difficult to assess whether or not it was better or worse than zoom or classroom. For example, the lack of facial expressions would be a greater problem if all the participants were unknown to me. (Survey 3)

Students were also divided in their responses of sharing and understanding knowledge – specifically tacit – in VR. Over half reported that they understood knowledge shared in VR well (53%) and very well (16%), whereas one-third (32%) answered "poorly." About half (53%) considered that it is possible to share tacit and embodied knowledge, but no one answered "very well." In terms of VR permitting the sharing of tacit and embodied knowledge, the other half answered "very poorly" (16%) or "poorly" (32%). A little over half felt that VR allows for socialization into the student community (well [40%], very well [15%]), and the rest were critical about it (poorly [35%], very poorly [10%]).

The students' responses to the open-ended questions suggest possibilities for the use of VR in supporting small-group collaboration and feeling more connected to peers – at least if the students know each other and know the face behind the avatar. Compared to meetings via Zoom, where it is possible to turn off one's camera, in VR, the students saw each other as avatars watching the lecture.

> It was nice to "see" others and to look at the lecture "together." The meeting rooms were nice, and it felt like we were really in a room together. (Survey 3)

Agency, for example, greater independence in students' movements, is an important attribute of virtual spaces (Burnett, 2024, pp. 495–496). Avatars in non-immersive VR can move and use limited gestures to communicate with others, but it takes practise. Moving in VR to form small groups for discussions caused mixed reactions, and others prefer the simplicity of Zoom breakout rooms. However, some students liked the autonomy of deciding how "near" or "far" they wanted to be from other avatars.

> The ability to move around and work in small groups made it more flexible. I could switch my positions and go closer to others or take distance from others. I felt more present than Zoom but less present than in an f2f situation. (Survey 3)

> It was nice that you can have different gestures and also move around, closer or more far from others. And, somehow, I felt that I'm in the same space with others, even though we really weren't. For example, in Zoom, I don't have this sense of being in the same space with others. (Survey 3)

> The "breakout room" [. . .] seemed more like an actual discussion than in Zoom. I'm a bit unsure why this is the case, though. (Survey 3)

Avatars lack the senses and presence of a human being, which seems to be connected to sharing (tacit) knowledge. No avatar can hide behind the black screen, as in

meetings via Zoom, but the human can hide behind the avatar. Without actual eye contact, the sense of social pressure and encouragement to invite people to talk is very different. Facilitating communicative knowledge sharing as an instructor avatar felt frustrating. The following quotes describe this from both the students' and instructor's perspectives.

> I'd say the ability to use senses was lessened in (the space) compared to Zoom or a classroom experience. The ability to see a person's face was missing, which turned out (to) affect the contact. (Survey 3)

> It felt more "present" than, e.g., in Zoom, but less than f2f. Somehow it was distant, although the avatars were side by side when you did not know if there is a person behind the avatar for real or not. (Survey 3)

> I was trying to make students talk there, which was AGAIN a bit challenging, but when I was doing that, I realized it is not the same as on site in Vaasa. [. . .] On site, I feel the social pressure. [. . .] I can make eye contact. I can see the students, their gaze, their movement when they see me watching them. They see I expect them to speak. They smile, change their position. They feel awkward. And, soon, someone speaks. GREAT! But there, they hide behind the avatars. I am behind the avatar. I don't feel the gaze in that way. I cannot make eye contact that way. I asked if they feel like they can lurk behind the avatar a bit. One student started talking; yes, this is exactly how she felt. (Instructor, diary, 20.09.2023, after the meeting)

Differences between Zoom, on-campus, and VR instruction for collaborative learning

In the second phase of the analysis, we asked whether students perceive differences between Zoom, on-campus, and VR learning in their opportunities to support knowledge sharing, learning, and group-based communication. The respondents were asked to evaluate a set of claims on a 4-point scale (1 = very poorly, 2 = poorly, 3 = well, 4 = very well). The analysis suggests that not all meeting spaces were estimated the same by the students in terms of all four main variables measured, namely 1) their perceived ability to support learning, 2) the students' estimates of how well they understood the knowledge shared about the course topic, and their perceived ability to 3) allow sharing tacit knowledge, as well as 4) support socialization into the student community (Table 2). This supports previous empirical research claiming that space indeed has an "impact" on learning (see Bligh & Crook, 2017, p. 3).

A few statistically significant differences ($p < 0.05$) were detected. Overall, the students estimated that VR did not support their learning as well as Zoom, f2f, and TPR, which were assessed to support learning equally well. The only significant difference in how well the students estimated to have understood knowledge shared about the course subject was detected when comparing VR to the TPR, with VR performing lesser than TPR. More statistically significant differences were detected in how the students estimated sharing and creating tacit knowledge: VR scored lower on both with a significant difference to f2f. It is noticeable that the students still consider f2f as the best support in sharing tacit knowledge and socializing into their community.

Table 2. Comparison of Zoom, on-campus, and VR instruction for learning.

	Comparison	P-Value	Conclusion
Perceived ability to support learning	**VR – TPR**	**0.023**	**significant difference**
	VR – Zoom	**0.012**	**significant difference**
	VR – f2f	**0.005**	**significant difference**
	TPR – Zoom	1.000	no significant difference
	TPR – f2f	1.000	no significant difference
	Zoom – f2f	1.000	no significant difference
Students' estimate of how well they understood the knowledge shared about the course topic	VR – f2f	0.367	no significant difference
	VR – Zoom	0.317	no significant difference
	VR – TPR	**0.049**	**significant difference**
	f2f – Zoom	1.000	no significant difference
	f2f – TPR	1.000	no significant difference
	Zoom – TPR	1.000	no significant difference
Perceived ability to support sharing tacit knowledge	VR – Zoom	0.639	no significant difference
	VR – TPR	**0.033**	**significant difference**
	VR – f2f	**0.027**	**significant difference**
	Zoom – TPR	1.000	no significant difference
	Zoom – f2f	1.000	no significant difference
	TPR – f2f	1.000	no significant difference
Perceived ability to support socialization into student community	VR – Zoom	1.000	no significant difference
	VR – f2f	**0.028**	**significant difference**
	Zoom – f2f	**0.036**	**significant difference**

Conclusions

This study explored and compared students' learning experiences in three hybrid learning spaces, which we named home/Zoom, classroom/TPR, and actual/virtual reality. To our knowledge, this is the first empirical study in higher education that explores and compares learning via Zoom, in VR, and on campus (see previous studies comparing Zoom and f2f, e.g. Serhan, 2020). According to the results, students find that f2f interaction is best for sharing tacit knowledge. However, overall, meetings in the classroom and Zoom supported interactive learning equally well, whereas VR was technically challenging yet regarded with curiosity. All three spaces support rather equally students' learning about the course topics. Evaluation of the possibilities and limitations of these technologies is affected by factors such as technical difficulties caused by unsuitable devices, distractions in the learner's physical environment, the degree of bodily presence

and non-verbal cues through the learner's body or their technical representation (screen or an avatar), how familiar the student is with the technology, and how relatable and human-like the digital versions of other people are. To sum up, whereas such hybrid learning spaces support place- and time-flexible higher education, they are not free from place. Instead, the home and actual reality blend with digital space; in addition, the human body's limitations blend with the technological being, which may cause distractions for communicative learning.

In general, a posthuman framework analyses collaborative learning experiences where technology plays a central role. Recent research on posthuman education has brought up the importance of exploring collaborative and embodied learning that includes both human and non-human actors (Woods, 2020) and the need for rethinking learner agency to enlarge learning possibilities (Charteris & Smardon, 2018, p. 52). Our study nuances such findings by comparing embodied learning experiences across three different technologies. However, posthumanism has been the subject of critique since it may decenter the human subject too far and overlook individual differences in, for example, learners' skills (Holloway et al., 2025). Our results acknowledge this limitation and demonstrate how some students found it more difficult than others to interact through the human-technology agencies and in the hybrid spaces although 96% of the students reported their confidence with technology OK to high (Table 1). This highlights the individual aspect of learning.

Our contribution to the education of geographers and the pedagogy of geography is three-fold. First, this article contributes to the discussion of the digital turn in the Journal of Geography in Higher Education. Even though geographers have widely accepted that digital turn has swept through geography (Ash et al., 2018), it has been little discussed in the pedagogy of geography (except for: Davies et al., 2019; Marcus, 2023; Waite, 2024). Ash et al. (2018)unpack the digital turn with three themes. Geographies *through* the digital means the transformation of creating and sharing geographic knowledge through new digital technologies, such as GPS and smartphones (Ash et al., 2018, pp. 27–29). We connect this to Davies et al. (2019) consideration of the digital turn in the context of photography and visualization and its dramatic change through new technologies. As photography and visualization are central in geographical education, geographers need to master these digital tools and to understand how these technologies transform their field (Davies et al., 2019). In this article, we develop pedagogy of geography *through* new digital communication tools, such as VR and TPR, that geographers need to master for sharing geographic knowledge and creating knowledge in teams whose members are located in different parts of the world.

Another theme that exemplifies the digital turn is geographies *by* the digital, encompassing the manner which digital technologies shape and change the way we experience and organize spaces and places (Ash et al., 2018, pp. 29–32). The last theme, geographies *of* the digital, signifies the study of the digital world itself as a unique space with its own rules and structures (Ash et al., 2018, pp. 32–34). In the Journal of Geography in Higher Education, these themes of the digital turn have been discussed by Marcus (2023) and Waite (2024), with both scholars focusing on the context of digital space. Waite (2024) sees the growing importance of digital spaces for sports, thus becoming a key part of teaching geographies of sports. Marcus (2023), p. 71) develops autobiography as geographical pedagogy to teach

students about the experience of place and "dimensions of geographic thought" that are created in cyberspaces where actual and digital space merge through digital map applications, for example. To develop these ideas, this article has presented how students' learning experiences take place in hybrid learning spaces that merge digital and physical space.

Second, this article contributes by suggesting widening the digital turn with the help of research in geographical pedagogy. We apply the concepts of hybrid space and a "posthuman learner", who attends meetings as a human being in the location of their body (e.g. at home) and as a technological being in the digital space (e.g. as an avatar in VR, a screen on Zoom, or a TPR in the classroom). Both the human and technological counterparts together enable and restrict interactive learning through, for example, the abilities to move, communicate clearly and make eye-contact. A human cannot attend such spaces without temporally adopting or merging with a digital counterpart, such as an avatar. The digital turn described by Ash et al. (2018) was published prior to the recent years' rapid development of generative AI, such as ChatGPT. These years have evoked vivid discussion in geography about technology's co-agency (Lundman & Nordström, 2023; Nordström et al., 2023). Our theorization of the "posthuman learner" follows similar lines of thought; thus, we suggest including a fourth theme for the digital turn: geographies *as* the digital.

Third, this article contributes with practical advice to include in the pedagogy of geography. We encourage instructors to incorporate new technologies into their courses and propose three guidelines for incorporating such technologies and for creating hybrid spaces that support interactive learning. First, f2f is the most efficient method to support the sharing of tacit knowledge and for socializing into a community. Thus, it is a good idea to include a f2f meeting with enough topic-related discussions and small-group work in the beginning part of the course. Second, Zoom is technically easy and supports interactive learning, which makes it a good, basic meeting platform for place-flexible synchronized learning. Third, non-immersive VR elicits curiosity among students and has important potential for interactive learning that enables "being there" together with other avatars – bearing in mind the limited experience of "being there" that non-immersive VR enables compared to immersive VR. To avoid technical issues and to facilitate students' familiarization with the VR platform, it is recommended to use one VR platform and one personalized avatar for each student across different courses.

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ORCID

Marianne Mäntyoja http://orcid.org/0009-0004-7103-0378
Johanna Hautala http://orcid.org/0000-0002-4451-6290

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