frontiers | Frontiers in Education

TYPE Original Research
PUBLISHED 19 October 2023
DOI 10.3389/feduc.2023.1155374

OPEN ACCESS

EDITED BY
Elżbieta Jarzębowska,
Warsaw University of Technology, Poland

REVIEWED BY
Liat Eyal,
Levinsky College of Education, Israel
Jun Xiao,
Shanghai Open University, China

*CORRESPONDENCE
Veruska De Caro-Barek
✉ veruska.de.caro@ntnu.no

RECEIVED 31 January 2023
ACCEPTED 26 September 2023
PUBLISHED 19 October 2023

CITATION
De Caro-Barek V, Lysne DA, Støckert R, Solbjørg OK and Røren KAF (2023) Dynamic learning spaces—dynamic pedagogy. Students' voices from a master's program focusing on student active learning in a cross-institution two-campus organization.
Front. Educ. 8:1155374.
doi: 10.3389/feduc.2023.1155374

Dynamic learning spaces—dynamic pedagogy. Students' voices from a master's program focusing on student active learning in a cross-institution two-campus organization

Veruska De Caro-Barek[1]*, Dag Atle Lysne[2], Robin Støckert[3], Ole Kristen Solbjørg[4] and Kari Anne Flem Røren[4]

[1]Student and Academic Section, Faculty of Social and Educational Sciences, Norwegian University of Science and Technology, Trondheim, Norway, [2]Department of Teacher Education, Faculty of Social and Educational Sciences, Norwegian University of Science and Technology, Trondheim, Norway, [3]Department of Mathematical Sciences, Faculty of Information Technology and Electrical Engineering, NTNU, Trondheim, Norway, [4]Education Quality Division, Section for Teaching and Learning Support, Norwegian University of Science and Technology, Trondheim, Norway

These past few years have shown the importance of successfully designing cross-campus and multi-campus hybrid and fully digital learning environments to sustain and guarantee continuity in learners' higher education - an aspect that has become pivotal to ensure the survival of Higher Educational Institutions in an increasingly digitalized world. Such learning environments, and related pedagogical practices, seem to contribute to promoting the development of the learners' critical skills to meet future work-life challenges and possible new crises. It is therefore increasingly important to include students' experiences and feedback to help develop and define standards and frameworks that can guide educators and other stakeholders in their work. This article presents the results from an exploratory case study within the frame of a larger research project closely linked to a cross-campus and cross-institution master's degree program at the Norwegian University of Science and Technology (NTNU). The master's program is a collaboration between NTNU and the University of Oslo (UiO) and is co-located at both campuses through one shared hybrid, physical and virtual, learning space called the Portal. The genesis of the Portal is informed by Radcliffe's Pedagogy-Space-Technology framework for the design and evaluation of learning spaces. The scope of our research focuses on the "user experiences", particularly on how students experience their learning space as an arena for student active learning and collaborations in a cross-campus (and cross-institution) organization. With this article, we hope to contribute to the research field in higher education by bringing in newer insight and, hopefully, a fresh point of view.

KEYWORDS

hybrid learning spaces, cross-campus/multi-campus teaching and learning, student active learning, virtual learning spaces, innovative teaching and learning

1. Introduction

The past couple of years have taught us the importance of online and hybrid teaching and learning to guarantee continuity of education. A new awareness has risen about the need to provide flexible and sustainable learning environments for learners throughout the educational system, and not only in times of crisis (Adedoyin and Soykan, 2020; Petronzi and Petronzi,

2020). How Educational Institutions, particularly in Higher Education, have behaved and adapted, and whether they have succeeded in maintaining the quality of education amidst global lockdowns are key factors that will determine their future (Dhawan, 2020). Successfully designing *hybrid (physical and virtual)* or *fully digital* learning environments that can sustain learners' education and promote the development of critical skills to meet future work-life challenges and possible new crises has now become pivotal to ensuring the survival of Educational Institutions in an increasingly digitalized world (Bozkurt et al., 2020; Hodges et al., 2020; Shearer et al., 2020; Williamson et al., 2020). It is therefore our ambition with this article to contribute to the important development and definition of standards and frameworks that can guide educators and other stakeholders in their work.

This paper focuses on the students' experiences in a hybrid learning environment and presents results from an ongoing larger research project closely linked to a cross-campus master's program at the Norwegian University of Science and Technology (NTNU). The research project started long before 2020 and is therefore *not* a result of the forced changes related to the pandemic. As such, it can provide good insight into the planning, implementation, and evaluation of cross-campus study programs in a normal non-pandemic situation. To get a full understanding of the subject matter, a parallel article (Nykvist et al., 2021) developed by the same research group has examined the standpoint of the educators and introduced their experiences.

Our project focuses on cross-university collaboration and flexible learning opportunities for students enrolled in a master's degree program in Music, Communication and Technology (MCT). The master's program is a collaboration between NTNU and the University of Oslo (UiO) and is therefore co-located at both campuses. The MCT program has managed and refined the development of a laboratory for networked-based musical communication called the *Portal*, two physical workspaces merged into an *extended and shared hybrid, physical and virtual, learning space for immersive learning mediated by technology*. Through the Portal, a 24/7 connection between the two universities was open to support and enable synchronous cross-campus teaching and learning activities, communication, and collaboration. In this shared and technologically enhanced learning environment, students and teachers together "explore, and evaluate pedagogical, spatial, and technical solutions, reflecting on this shared presence's theoretical and practical possibilities and limitations" (Støckert et al., 2019; Støckert and Tidemann, 2022). In our study, we have chosen to define a hybrid learning space as both a physical and virtual environment for learning "where the focus is not merely on the notion of online and offline learning spaces, but also acknowledges the changing roles of teachers and students in these spaces and promotes student agency" (Hilli et al., 2019; Nykvist et al., 2021).

The genesis of the Portal is informed by Radcliffe's Pedagogy-Space-Technology (PST) framework (Radcliffe et al., 2008) for the design and evaluation of learning spaces. The scope of our research is an in-depth analysis of the students' experiences, of how they have experienced their learning space as an arena for student active learning and collaborations in a cross- campus (and cross-institution) organization. There are two reasons why we chose this hybrid program as a case study. The first reason is that hybrid learning environments acknowledge both the argument for meeting up on a physical campus and the one for the flexibility offered by online teaching and learning. The second reason is that the MCT master's program, in particular, focuses on student active learning and hands-on problem-solving with regard to authentic learning tasks.

Firstly, we will discuss Radcliffe's Pedagogy-Space-Technology framework. We will then explain why we perceive the need for a modification of the traditional framework while setting forth our adapted version. In our approach, we will suggest employing principles within PST that can promote student active learning and cater for better interaction and collaboration among students, and between students and educators, through authentic work-life tasks. Secondly, we will argue for a *pedagogy-first* approach in designing, delivering, and running hybrid, physical and virtual, learning spaces with teaching and learning activities where the learners are placed at the center of the experience and share a common responsibility to shape and support the learning environment they cohabit with their educators. Teaching and learning are context-dependent. In this article, we have therefore chosen to examine in- depth, through a phenomenological approach, how MCT students have experienced learning and working collaboratively, and being social in the Portal.

The following research questions were investigated:

What do MCT- students tell about their experiences with collaborative and student-active learning activities in the Portal?

What do MCT- students tell about the Portal as an arena for learning and social activities? Finally, we will open for further discussion in the conclusive part.

2. Literature review and project background

In the following paragraphs, we will highlight relevant literature contributions from related research fields, and we clarify the backdrop for our project.

2.1. A phenomenology of learning spaces

Research on teaching and learning spaces in Higher Education is a relatively new and still underrepresented field. Studies in educational architecture have mostly tended to focus on the material space itself (Boys, 2011), and on how the design of educational buildings embeds a representation of the mission and values of the commissioning institution (2011, p. 169). Architects try to convey an abstract ideal of Education by concretizing it into a built space (Ellis and Goodyear, 2016, pp. 157–158). Consequently, the building of learning environments has mostly focused on infrastructure solutions. This paper wishes instead to turn the research lenses onto the life unfolding in the learning environment, as this vital aspect has often been overlooked. It is the authors' belief that learning environments should reflect the dynamics of real human interactions. Research in the field should therefore investigate how those interactions change and unfold in time and space, being this space a physical entity on campus or the cyberspace of the Internet of Things. In this respect, this paper is an attempt to offer more nuanced guidelines for the design and implementation of learning environments, physical or networked (hybrid and fully digital). The last two decades have fortunately witnessed an increased interest and development in socio-material

perspectives in human sciences (Ellis and Goodyear, 2016). Researchers with different backgrounds in the social and human sciences seem to have converged their research interests and efforts in trying to better understand, theorize and define the relations that connect the material world (space, place, and tools) to human activity, thought and language, and learning (Ellis and Goodyear, 2016). The concept of "bodily" materiality of our existence as expounded in Merleau-Ponty's Phenomenology of Perception lies at the core of the understanding of how human beings perceive and build their own identity in the bodily space of the world (Merleau-Ponty, 1945; Merleau-Ponty, 2010). So-called phenomenological approaches in architectural design have been influenced by Merleau-Ponty in a continuum from the late 1950s until today with a renewed focus on the impact of space, materials and light on the human senses (Sirowy, 2017; Tamari, 2017). Phenomenology in architecture is even more relevant today since today's architecture, and particularly, public architectural design is challenged by the necessity of including new emergent technologies in a complex and comprehensive spatial picture where human beings interact with physical as well as virtual artifacts (Tamari, 2017).

Parallel to this development, awareness of the need for what we can call *a phenomenology of learning spaces* has emerged from the beginning of the 2000s. In this context, recent contributions to learning space research seek to theorize practice to inform a design, management and evaluation of learning spaces that take into consideration the agency of the users involved, students, educators, administrators, and designers (Støckert and Stoica, 2017; Goodyear, 2020).

2.2. Pedagogy, space, and technology

Much of the published literature concerning learning spaces has mirrored a paradigmatic development in pedagogical currents, from behavioristic approaches to more progressive and socio-constructivist approaches to teaching and learning (Baars et al., 2021). The direct link connecting this transition to the dramatic increase in the availability of digital technologies is now a well-established side of the social sciences' discourse (Baars et al., 2021). While we watch society projecting itself through the 4th industrial revolution and toward a future 5th revolution of digital humanism (Thurston and Hayes, 2021), the traditional role educational institutions have had for centuries, as exclusive knowledge providers, has now been challenged by the competition of new players in the open and private education business community. The broad availability of online educational platforms and online courses offers learners throughout the educational sector a previously unimaginable level of flexibility and accessibility (Pates and Sumner, 2016). The next generation places of learning (Radcliffe et al., 2008; Radcliffe, 2015) is no longer delimited by the physical perimeter of educational institutions' buildings. There is a growing international consensus that in the imminent future, it will be crucial to develop and offer hybrid learning environments that are *flexible in form and time*, with a general understanding that learning takes place also informally and in "cross-border" collaborations (Leijon and Tieva, 2021, p. 33). This turn of events has caused educational institutions to re-think and redesign their physical learning spaces and adapt more to the needs of twenty-first-century learners. However, a somewhat myopic focus on learning space design and technology seems to overshadow the need for a more in-depth conversation on pedagogy (Pates and Sumner, 2016). In Higher Education in particular, despite the broader consensus on social constructivist teaching approaches as most effective in terms of enabling student learning (Stover and Ziswiler, 2017), the journey from frontal teaching in auditoria to student-centered active learning is by no means the norm.

Radcliffe's intention when conceptualizing the Pedagogy-Space-Technology framework (2008) was to offer a reference tool to ease the convergence of pedagogical practices, design of physical learning spaces and implementations of technology to create new models of campus interaction, where optimal learning space design can support student learning (Manciaracina, 2019).

Figure 1 pictures the interrelated constituents of the Pedagogy-Space-Technology framework (PST). Each of the three elements (pedagogy, space and technology) exerts mutual influence on each other creating a circular course of actions that embodies the life cycle of the learning space (Radcliffe et al., 2008, p. 14).

To ensure PST's maximum flexibility for its stakeholders and their agendas, whether they are administrators, faculty, architects, students and /or equipment and technology providers, the framework *does not* mean to suggest a hierarchy to value one element more than the other (Radcliffe et al., 2008, p. 14). Radcliffe's PST framework has since been theoretically referred to and practically implemented in different educational scenarios, from online mooting court activities for Law students in Australia (Ng, 2015) to active learning classrooms with a focus on social learning in American universities (Zhu and Basdogan, 2021). The trend we are witnessing nowadays is that PST has slowly moved from being a framework most suited for physical learning spaces on campus (Lee et al., 2018; Manciaracina, 2019; Casiraghi et al., 2020; Zhan et al., 2020) to becoming a reference also for *hybrid* and *fully online* learning spaces (Xiao et al., 2019; Pan and Zhu, 2020; Xiao et al., 2020).

However, upon closer examination, even in PST the pedagogical element seems to play a more passive role. Pedagogy is "enabled by space" and "enlarged by technology." Space "encourages" Pedagogy and Technology "enhances" it. There is no actual agency related to the pedagogical thought and action. In its present form, PST can be (mis)interpreted as a framework that rather places a heavier

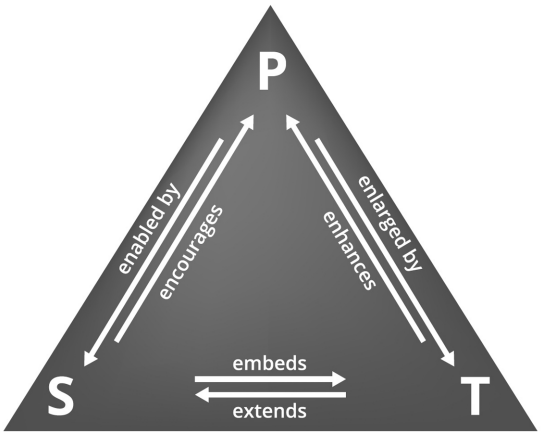

FIGURE 1
Adapted from Radcliffe's PST framework (Radcliffe et al., 2008).

focus on physical and technological form than pedagogical substance. Therefore, in the next section, we will argue for a *Pedagogy-first* approach when conceptualizing a framework for student-centered hybrid and virtual learning environments.

2.3. Pedagogy first and the human factor

Cleveland and Fisher (2014) have critically analyzed methodologies and methods used to evaluate learning environments in Higher Education in view of contemporary approaches to teaching and learning. One of the interesting references is to Radcliffe's PST framework as a useful guide not only to design but also to evaluate learning environments with a direct link to students' learning outcomes (Cleveland and Fisher, 2014, p. 10). However, Powell (2008, in Radcliffe et al., 2008) suggests that this type of evaluation can be very difficult since learning outcomes depend on a significant and uncontrolled number of variables and contributing factors beyond space and technology that concern more the kind of teaching and learning activities carried out in the learning space than the space itself (Powell, 2008, p. 29; Cleveland and Fisher, 2014, p. 11). With a background in the phenomenology of learning spaces outlined earlier on, it becomes clear that those "significant and uncontrolled variables and contributing factors" influencing teaching and learning activities in the learning environment must refer to the unpredictable ways of human agency. In other words, how the interaction between the users, students and educators, is mediated in the learning space with and through technology. On this note, a more recent critique of the PST framework by Manciaracina highlights the incompleteness of the framework, as the presence of users seems to be missing (2022, p. 94). He argues that in a learning space that follows human-centered design approaches, the focus on the type of interaction and the user is what should guide the design. The PST framework reflects on the creation of learning environments to facilitate participatory learning-centered experiences. However, it does not account for the users and their interactions as "both actors and directors, enablers and resisters, learners, and instructors." (p. 94). These multifaceted aspects of human interaction are what we define as *the human factor*. The human factor is the X-variable that is notably absent in the equation of the PST framework, as the framework itself does not emphasize the pedagogy and the users.

However, Pedagogy is *de facto* the only constituent of the framework that can express and actualize any agency since it manifests in the interaction between educators and students. Learning spaces do not exist *a priori*, they only exist where and when students and educators are present. Along with the same logical thought, technology is of no use if not employed by someone. The human factor should therefore be the encompassing element at the very core of any framework trying to define, design and implement learning environments as it is the only element that can account for pedagogical agency. It can be used to identify and recognize users' behaviors at different levels of interaction: how educators interact with students, students interact with their peers, educators interact within their fellow academic community, and how all can contribute to creating an intellectual community of users who are interested in innovating their learning environments.

The human factor also includes all the concepts within Community of Inquiry (CoI) (Garrison et al., 1999): Cognitive Presence, Social Presence, and Teaching Presence.

In Community of Inquiry (CoI), cognitive presence refers to how participants are able to construct meaning through communication, social presence is defined as the ability of participants to present themselves to others as "real people," and teaching presence refers to the responsibility usually befalling the educator or instructor to design and facilitate the educational experience (Garrison et al., 1999, pp. 89–90). These three interconnected elements are believed to support learning (Kilgore and Lowenthal, 2015, p. 3). While researchers earlier on investigated each single element of CoI separately, there has been a shift in the last decade to view CoI as a unity, particularly in studies examining online teaching and MOOCs (Ke, 2010; Kilgore and Lowenthal, 2015, pp. 3–4). This trend is understandable when considering the parallel development of Network Learning (Dawley, 2009; Hodgson et al., 2012) and "of a learning culture in which the members value supporting each other: no one individual is responsible for knowing everything" (Hodgson et al., 2012, p. 295). Human interaction is the very core of the ontology and epistemology of Networked Learning because "knowledge emerges or is constructed in relational dialogue or collaborative interaction—knowledge is not a property but a social construction/way of knowing from our experience of the world" (Hodgson et al., 2012, p. 293). The missing link in the PST- framework that glues everything together is indeed human interaction, or the human factor, as we call this element that accounts for the interaction between students and educators, students and students, educators and educators, and how this interaction concretizes itself in collaborative teaching and learning practices.

This is the reason why in our approach, we have decided to modify Radcliffe's initial PST in a way that can strengthen and highlight the position of Pedagogy and the human factor encompassing the framework by including the educators' and the students' points of view. We wanted to hear directly from the users how they perceive teaching and learning in such a collaborative-based learning environment. In our version of PST, the human factor encases the framework itself by directing a deliberate focus on Pedagogy as the element expressing the agency of human interactions in learning spaces (Figure 2).

In this modified framework, Pedagogy materializes in the promotion of collaborative learning and student active learning activities that inform both the design of the Space and the choice of Technology accordingly. While Space embeds Technology and Technology expands Space, they are both subordinated to the pedagogical agency and how educators and students choose to collaborate in their learning spaces/arenas (physical, hybrid, and fully digital).

In a parallel article, we have investigated this aspect from the educators' point of view, and we have reported on their experiences and the pedagogical choices they made during the 2 years of running the MCT master's program within such an innovative frame (Nykvist et al., 2021). In the following sections, we will report on the student's experiences from our current study. Our investigation analyses how MCT students have perceived studying and working in the peculiar learning environment called the Portal and, in particular, what their experiences have been regarding student active learning and

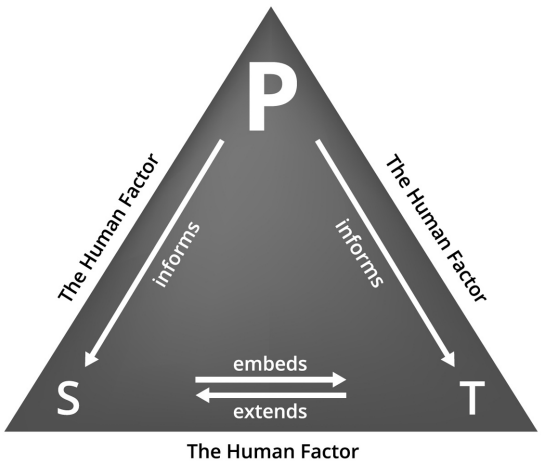

FIGURE 2
Our modification of the PST- framework. Pedagogy first and *the human factor.*

collaborative learning activities in this hybrid cross-campus learning space.

2.4. Music, communication and technology and the SALTO-project: student active work forms in a cross-campus (and cross-institution) student-centered learning space

The MCT master's program constitutes "the living lab and testbed" for the research program SALTO. The SALTO project represents the concretization of a pedagogical vision that values collaboration and knowledge-sharing among students and educators and goes beyond educational institutions' classical physical barriers. SALTO is based on a study situation where students, while located at two different Norwegian universities, are enrolled in the same joint master's program (MCT). The scope of the research in SALTO encompasses the development, investigation and evaluation of cross-campus/cross-university hybrid learning spaces and teaching and learning solutions. This is a highly relevant issue in Norway given a structural reform from 2016, a more recent proposition for a new law regulation of the HE-sector (Meld. St. 18, 2014-2015; NoU, 2020), and the larger international context addressing the future development of Higher Education toward hybrid and remote teaching solutions to ensure equality and sustainability of education throughout lifespan learning (Ali, 2020; Murphy, 2020; Tesar, 2020; Harkavy et al., 2021).

The project manages and refines a two-campus hybrid learning space for physical-virtual interaction across the web called the Portal where students and teachers explore educational, methodological, and technological solutions *together* (Støckert et al., 2019, 2020a,b).

The aim has been to develop effective pedagogy with synchronous student-centered learning activities at both campuses, with particular emphasis on interaction, resource sharing and communication. Established strategies for student-active learning have been adapted in a "cross-campus" context while being anchored within Radcliffe's Pedagogy-Space-Technology (PST) framework (Radcliffe et al., 2008) for sustainable design of physical *and* virtual learning spaces. Key pedagogical approaches and relevant activities at the base of the MCT master's program have been:

- Collaborative learning: Project work, problem-based learning and development projects in groups across campus.
- Flipped classroom: Development of digital learning materials and common methods for in-depth study, discussion and application of subject matter across campus.

The choice of a master program in Music, Communication and Technology lies in the assumption that if pedagogical and technological innovation can overcome spatial challenges and facilitate communication and collaboration through flexible solutions, resulting in productive crossings between musical performance and technological innovation, then the same innovative approaches can successfully be employed in other subject areas.

3. Methodology

With our focus being on the "common human experience for a number of individuals" (Creswell and Poth, 2018, p. 82) and the description of phenomena from the perspective of the participants/students, in this particular exploratory case study (2018, p. 96–99), we have opted for a phenomenological investigation through semi-structured interviews (Creswell and Poth, 2018) and research methods inspired by Grounded Theory (GT) (Thornberg, 2012; Thornberg and Charmaz, 2014, pp. 153–169; Charmaz and Thornberg, 2020). The inspiration from GT manifests specifically in the choice of the Constant Comparative Method of Analysis (CCMA) (Postholm, 2019) as a research method. We chose to apply CCMA because of its wide versatility and rigor. While CCMA traditionally is employed within GT and is meant to contribute to new theory development (theoretical analysis), it is also widely employed within other research epistemologies and methodologies to give a thorough description of a phenomenon (descriptive analysis) (Postholm, 2019; Kara, 2020).

One of the core concepts in CCMA entails the *theoretical sensitivity* of the researcher and their active role in looking for patterns and explanations through comparisons and interpretations (Reichertz, 2019, pp. 260–261). In our group consisting of five researchers with diverse academic backgrounds, this concept has been a paramount guiding element for data collection, analysis, interpretation, and validation (Postholm, 2019, pp. 97–98). CCMA's *abductive research approach* (Reichertz, 2019) with emphasis on the researchers' pre-understanding and interpretation abilities directed data analysis throughout the analytical process.

After an initial open coding phase which led to the definition of categories and subcategories relevant to the material of our study, we conducted several condensation cycles up to category saturation. At least four of the five researchers were present at any given time during the subsequent condensation cycles to validate the analytical process and interpretation of the data. The results of this analytical process are rich and thick descriptions that express the participants' points of view. This approach by including CCMA has allowed us to gather richer data and achieve a deeper analysis of the phenomena investigated than we could have done with the sole help of either a pure phenomenological or a pure grounded theory research approach.

3.1. Our participants

The MCT- program has been recruiting students from all over the world, so our project participants presented good variation in language and cultural backgrounds with a larger number of international students. All students had a proficiency level in English as a requirement for enrolling in the program. Of the total 21 students who enrolled into the MCT program from the start in September 2018 and up to 2020, we chose to interview those ($N = 12$) who had been students at MCT for at least one semester and had experienced the program both before and during the pandemic. Five students ($n = 5$) enrolled in the program in 2018, and seven ($n = 7$) in 2019. We identified these students as the ones more apt to offer us a greater amplitude of reflections on their experiences as they had been able to participate in learning activities both physically on the local campuses, in the shared hybrid format connecting the two universities, and then completely digitally during the lockdowns.

Our 12 participants consisted of both Norwegian and international students, two ($n = 2$) females and ten ($n = 10$) males. As showed by these numbers, female students were unfortunately underrepresented in the program. However, for the purpose of this paper, gender differences were not investigated. With just two female students, the individual differences in character and personality of the participants seemed to play a bigger role than gender to generate a significant impact on the results. However, gender differences as a contributing factor to the low representation of female students in technology-related academic subjects is without doubt a relevant research angle that needs to be better investigated.

3.1.1. Sample size

Regarding the sample size, we believe that in the type of investigation we conducted, with a phenomenological approach (Moustakas, 1994) to semi-structured interviews, 12 participants should constitute a sufficient sample size. Texts in descriptive (Giorgi, 2009), hermeneutic (van Manen, 1997), and transcendental (Moustakas, 1994) phenomenology do not specify an adequate number of participants. However, Creswell and Poth (2018) point to Polkinghorne (1989) suggestion that phenomenological research approaches ought to contain participant samples between 5 and 25. With 12 participants, our study lies in the average sizing and therefore should be sufficient to answer our research questions.

3.2. Data gathering and analysis

The research project was presented to and accepted by the Norwegian Centre for Research Data (NSD) by the beginning of 2020. Data was then gathered via semi-structured interviews between autumn 2020 and summer 2021, and the interviews were transcribed soon after.

We used an interview guide where questions were designed to make the informants talk freely about topics such as previous experiences with cross-campus teaching and learning, which kind of learning activities they had in the MCT program, and which learning spaces/arenas they used. Participants were also specifically asked about their experiences with the Portal as an arena for learning and social activities and about collaboration-based learning activities in the Portal. The interview guide is available in Supplementary Appendix.

The interviews were conducted online via Zoom and were audio-recorded using a Dictaphone app provided by the research data collection facility at Oslo University (Nettskjema). Interviews were then transcribed manually and stored in Nettskjema.

Thereafter, a phenomenological analysis (Moustakas, 1994) was conducted in order to identify blocks of information relevant to answering our research questions. The blocks of information were then structured, organized, and analyzed through a process of *open coding* (Corbin and Strauss, 2015) with reference to the constant comparative method (CCMA) (Postholm, 2019). This process led to the definition of main categories and sub-categories named on the base of the type of information that emerged during coding. Categories and sub-categories were discussed according to which part of our modified version of the PST framework they described, such as *Collaborations* for the Pedagogy part of the framework and the *Portal* for Space and Technology The coding process was simplified using the software NVivo, and an excerpt from our coding tree is available in Supplementary Appendix. Each interview was categorized following the same procedures.

In the stage of *axial coding*, connections between categories and sub-categories were then explored vertically by analyzing which sub-categories seemed to present a logical connection, which of them stood intuitively in relation to one another, and how their relationship could be investigated. In this exploring phase, the categories "Collaborations in the Portal" and "Portal as an arena for learning and social activities" emerged as the most prolific since most of the participants' statements from interviews could be labeled thereafter. Each category was then condensed and refined subsequently. The condensed texts for each category were then assembled across all interviews and condensed once again. We ended with a final text that comprehensively described the participants' experiences and beliefs across interviews for each of the identified categories and in light of our modified PST (excerpts available in Supplementary Appendix). Validity in the process was secured by triangulation between all five researchers in the research group and by the constant comparison of data throughout the analysis phases. Following Creswell and Poth (2018, pp. 258–259), "validation" in qualitative research can be considered a process and an attempt to assess the "accuracy" of the interpretations of the participants' statements made by the researchers. This view strongly suggests that any qualitative piece of research is a representation by the authors. However, the extensive time spent dwelling on the research data, the detailed thick descriptions following the condensation cycles, and the closeness of the researchers to participants in the study all add to the value or accuracy of a study. It is worth noting that validation in this case, and for the reasons just exposed, cannot be equal to *verification* which would imply quantitative ambitions we do not have for the present study.

4. Results and discussion

In the following, we present and discuss the results from our analysis examining the categories "Collaborations in the Portal" and "Portal as an arena for learning and social activities" in MCT as emerged during the condensation process and considering our modified version of PST including the human factor.

TABLE 1 Summarization of research results.

Collaborations in the Portal	
Pedagogy	
Keystones promoting cross-campus collaborative learning	Keystones hindering collaborative cross-campus learning
(A) *Supportive learning environment providing relevant learning activities based on students' interests and previous knowledge (team-based projects/hands-on activities)*	**(C)** *Potential issues related to the distribution of responsibilities between students and educators and among students, lack of time (tight schedules for projects and related activities), students' uneven level of competence (including English proficiency)*
(B) *Diversity of competencies in group, strong group union and student involvement that promote a shared sense of ownership*	**(D)** *Lack of students' understanding of prerequisites for succeeding in group projects (problem-solving strategies and net-etiquette)*
The Portal as an arena for learning and social activities	
Space and technology	
Keystones promoting the Portal as an arena for learning and social activities	Keystones hindering the Portal as an arena for learning and social activities
(E) *Formal and informal, hybrid (physical and virtual) learning arenas that inspire a sense of co-presence*	**(G)** *Not enough balance between "sufficiency"* versus *"optimization" of chosen technology (stop when it's good enough)*
(F) *The importance for students to create and organize their own additional learning arenas*	**(H)** *Lack of "net-etiquette"*

Because *collaborations in the Portal* pertain to the domain of organized teaching and learning activities, we will first discuss this category in connection to the element of Pedagogy from PST.

Space and Technology will subsequently be discussed in the section regarding the Portal as an arena for learning and social activities.

Table 1 summarizes the results in an easily accessible overview, while the following paragraphs will offer an in deep explanation.

4.1. Collaborations in the portal (pedagogy)

This section presents our results for the category *Collaboration in the Portal* in a double list of keystones, or key aspects, that either seemed to promote or hinder collaborations and collaborative learning in the hybrid cross-campus setting of the Portal. In such a setting, groups were put together across the two university campuses through the Portal to work on both hands-on and theoretical tasks. The intention was to determine whether and how pedagogical and technological innovations could minimize the potential negative effect of not being physically present on the same campus.

As mentioned earlier, the following keystones can be better understood in light of our modified PST framework and the human factor, where the three components of Pedagogy, Space and Technology work in a continuum and act symbiotically within a highly interactive learning environment. This section presents and discusses the keystones with reference to Pedagogy.

4.1.1. Keystones promoting cross-campus collaborative learning

A. *Supportive learning environment providing relevant learning activities based on students' interests and previous knowledge (team-based projects/hands-on activities).*
B. *Diversity of competencies in group, strong group union and student involvement that promote a shared sense of ownership.*

The pedagogical pillars in MCT have been firmly anchored in student active learning (Bonwell and Eison, 1991; Mizokami, 2018), flipped learning (Bergmann and Sams, 2014), and peer learning practices (Boud and Cohen, 2014), with continuous dynamic adjustment in course content and activities in order to secure adaptive teaching and learning (Westwood, 2018; Mirata et al., 2020).

The Portal provided a great experience for students to *learn how to learn* and collaborate in a hybrid environment (physical and virtual). Hands-on activities, in particular, were challenging but rewarding because solving complex tasks made students extra conscious of the interplay between pedagogy, space and technology.

In the cross-campus setting of the Portal, teacher availability *in loco* paired up with cross- campus and/or externally hired teaching expertise has been proven to be a prerequisite for good teaching and learning design, particularly in practical/hands-on learning settings promoting students' learning process (ref. keystone A). While it has been challenging to cater for different needs and choices, for students, groups and teachers (individual guidelines, timeframes, teacher support and flexibility in learning activities), learning in groups has positively worked cross-campus. Important elements for successful group collaborations in projects have been a focus on students' learning preferences (e.g., personal interests) (keystone A), students' involvement and the possibility to choose, and facilitation of cooperation between team members and development of personal relationships (ref. keystone B).

Students' feedback highlights the importance and relevance of having a shared collaborative learning experience with their educators and a sense of ownership that came to light by working together. They expressed a collective positive response to the effort educators made in tailoring the learning activities based on students' interests and previous knowledge. On that note, it is interesting to point out that the educators interviewed in a parallel article expressed very similar opinions (Nykvist et al., 2021).

Students underlined that such *ad-hoc* research and developmental learning activities were more important for engagement and motivation than the mediating technology used in the Portal. It was the relevance of the learning activities, in the form of authentic working challenges in

cooperating companies, that sparked motivation and interest; something that has been discussed in the research literature for the past 40 years and is becoming steadily more relevant for teaching and learning practices in our digital age (Anzai and Simon, 1979; Lowell and Campion, 2020). Moreover, our analysis shows that hands-on problem solving with peers improves collaborations and motivation giving rise to a shared sense of ownership to the project and a higher perception of learning. Students commented that peer collaboration can give deeper insights into one's own level of knowledge opposed to a traditional setting where students basically only study by themselves for themselves only: "[…]everyone around you collaborate and communicate about the content and you know better where you are, you see where the others are. And if you are in a traditional setting, you just listen and then you basically just study by yourself." Similar conclusions have been showed time and again by current research (Caspi and Blau, 2011; Thibodeaux et al., 2019; Blau et al., 2020). Another quote from one of our participants exemplarily sums up: "I learn a lot of by other students, like, in working with these in workshops […] I think it's really good because in, […] you learn from each other. I mean I have learned a lot from other students, like how they did something certain things and I ask from them and they show me and then discuss and so, yeah, it's quite collaborative learning I think."

4.1.2. Keystones hindering collaborative cross-campus learning

C. *Potential issues related to the distribution of responsibilities between students and educators and among students, lack of time (tight schedules for projects and related activities), students' uneven level of competence (including English proficiency).*
D. *Lack of students' understanding of prerequisites for succeeding in group projects (problem-solving strategies and net-etiquette).*

Even though diversity in group competencies was most of the time an asset to group dynamics, differences in the level of competence and motivation among students could at times also aggravate group advancement (ref. keystone C). Building and maintaining the Portal was a great and somehow time-consuming responsibility. Not all students were attuned to contributing in the same way, and this gave rise to motivational conflicts (ref. C). One student tells "I think sometimes there were a kind of some students may have wanted more guidelines for what was going on, for others maybe creatively inclined or more familiar with that sort of project set-up, working with hardware or software and music, those people really excelled having just a few guidelines and pursuing what they wanted and what their interests were. I would say I'm in between. There were some cases in some classrooms where some guidelines would have been more helpful so that you could tether the scope."

Another problematic issue, that perhaps also contributed to exacerbating underlying conflicts, has been tight schedules and limited timeframes for group projects (ref. C). The pressure of tight time constraints could lead to stressful situations, where students more often than desired decided to rely on their previous competence instead of challenging themselves in weak competence areas. Lack of time is an enemy to learning development and educators should take this aspect into careful consideration when scheduling their courses, allocating enough time to projects and hands-on activities.

Too wide a gap between students' competence level and degree of commitment could have a negative impact on the perception of accomplishment and meaning of the task when involved in very demanding hands-on activities of the technological type (ref. D). One informant remarks: "[…]we would solve specific tasks or those tasks together or as a group and it was a tour to reflect on oneself in the group. It was mostly group work and that required a lot of individual engagement, so, it was, yeah. It worked most of the time, well. Of course, there were also instances where I could not contribute somehow or not as I wished. But then I feel disrespect. Everyone probably had those moments, probably. […]Maybe not that, but where I had difficulties to say, it was just weird to meet different interests. I felt a little bit overridden maybe? But yeah, it was just a matter of how do you present your idea, or how comfortable do you feel."

There are multidimensional issues related to the distribution of responsibilities among students, but also between students and educators. It can be challenging to design hands-on learning activities based on students' interests and previous knowledge in a setting like the Portal and maintain a good balance between pushing learners and accommodating their needs. One of the issues here refers to Vygotsky's Zone of Proximal Development which varies for each student (Doolittle, 1997; Levykh, 2008). When the proximal developmental zone is pushed too far away from the learner, motivation starts to fail (Levykh, 2008) and results suffer. Other issues we noted refer also to the complexity of human nature. Some of the students, particularly the ones coming from a more hierarchical pedagogical background and not so accustomed to taking charge of their own learning, felt they were perhaps pushed too much. Some younger and/or less experienced students could feel way too much out of their comfort zone. Others would shy away from taking responsibility as they would feel more visible and exposed, hence more vulnerable in the process (ref. keystone D). But all in all, students were positively surprised by the learning progress they made during the master's program and recognized the value of being challenged, as a way to deepen their learning process and expand their skills dimension.

Other aspects that had a negative impact on collaborations were language and cultural barriers (ref. C: fluency and confidence in English), differences in individual problem-solving strategies, lack of competence, and lack of students' understanding of how to behave and work in group (ref. D): "[…]we all have very different ways of working. So, it varied how well it [collaboration] worked in terms of the individual's strategy methods, but I think it has at least been very educational, to be able to work together like that. It can work very well if you are put in groups with someone you work well with and can work less well if you are put in groups that do not work so well."

However, we cannot pinpoint those aspects to the specific cross-campus hybrid setting of the Portal, as similar conflicts in collaborations may well arise in traditional *on-campus* learning settings too. Nonetheless, students had no problem solving these issues on their own or with the help and guidance from their educators when needed. Dialogue is paramount in any setting, but even more when participating in a cross-campus hybrid or fully online studying and working environment. In this case, the importance of net-etiquette when studying and working digitally resonates with current literature on social practices and/or Community of Inquiry-practices (Fiock, 2020; Rodríguez-Triana et al., 2020; Stevenson and Bauer, 2020; Oyarzun et al., 2021).

4.2. The portal as an arena for learning and social activities (space and technology)

When examining students' experiences in and with the Portal with reference to the space and technology elements within PST and the human factor, four keystones were outlined with related strengths and weaknesses:

E. *Formal and informal, hybrid (physical and virtual) learning arenas that inspire a sense of co-presence.*
F. *The importance for students to create and organize their own additional learning arenas.*
G. *The importance of balance between sufficiency* versus *optimization of chosen technology (stop when it's good enough).*
H. *The importance of "net-etiquette."*

4.2.1. Space

A crucial part of the master's program curriculum entailed the physical set-up of the infrastructure in the Portal. The very coming into existence of this learning environment became both a major part of students' learning activities and a physical and virtual space they could design, modify and adapt to their own needs. Despite initial hick-ups and technical challenges that put students' patience to the test, working in the Portal enabled a sense of co- presence (Bulu, 2012; Kim et al., 2016) as communication could happen freely in the physical and the virtual space, and multiple (physical, hybrid, online) arenas were used for formal and informal purposes (ref. keystone E). As one participant says, "in the Portal, you can have a social gathering, like with two campuses… that's functional." Even when students agreed on the extra social dimension offered by face-to-face encounters, the Portal made it nonetheless easy to communicate and collaborate at a distance at a high level of interaction, as it could be used for formal learning activities as well as informal meetings and even cross-campus jam-sessions. In this technology extended space, students established their own additional arenas for asynchronous and/or synchronous communication and interaction, and formal and informal collaborations (ref. keystone F): "Then we have other studios where we can do different group meetings at the same time and this is really important for teamwork, for projects to work in groups of four and not all the class at the same time. We also have a Discord server, we use it a lot, we have a lot of different channels.

We do not have only channels for the courses, we also have channels for sharing music, sharing Inspiration, and gear and software, and yeah we use it a lot."

Our results suggest that formal and informal social interaction within and through the Portal works better in smaller groups, while one-to-one communication and multi-discussions are difficult in plenary settings, particularly with reference to audio quality. Our findings on this aspect of communication and interaction come not as a surprise as they resonate with other studies on distributed teaching and learning (Mishra et al., 2020; Onyema et al., 2020; Snoussi and Radwan, 2020). We believe therefore that diversity in learning spaces and arenas should mirror the diversity of human interaction in establishing sustainable learning environments in all modes of study, on-campus, hybrid and fully online. Space should allow for students to find their own way of communicating and creating shared learning arenas of their own.

When corona struck, students working in the Portal felt they had an advantage as the Portal had contributed to improving their collaborative capabilities to work in fully online learning environments. However, students still report that relationships are indeed easier to establish on-site than in a distributed setting between two campus locations, and that physical (face-to-face) presence between students and educators is still easier. Having professors on-site facilitating the hands-on problem solving locally during the program was not just helpful but also contributed to the perception of equality and belonging between the two campuses.

While lockdowns have shown us that it is both possible, practical, and convenient to meet, collaborate, study and work fully online, it seems that our very brain architecture, how we are wired together, has behavioral preferences of its own and face-to-face contact is still irreplaceable (Nowak and Biocca, 2001; Lieberman, 2014; Harviainen, 2016). One other participant claims: "When we have online meetings like this of course it is not as personal as having the people at the same place." Even when informal social arenas can be established in hybrid and virtual settings, like in the case of the Portal, it still seems important to meet in person first. To meet in person positively affects social relations and thereby lays a foundation to establish a context for later cross-campus collaboration online. That's one of the reasons the program organized an exchange trip between campuses at the very beginning of the 1st year. The students who had the possibility to get to know their fellow students on the other campus collectively report this as a positive and decisive experience:

> "Yes, I think that was very important. It was, yes it (reformulates) I think it was very like that, then you get a picture of people very quickly, then you have the opportunity to talk to people a little more one to one (reformulate) yes no no I think it really was very important. I do not quite know if I can explain why, but the (reformulate) setting was a bit different as well, so it was more characterized by the fact that it was (reformulates) we went around and investigated things and it was a bit more like an introduction, and it was also (reformulates) we had social events in the evenings and stuff, so. It was good to lay that foundation, so to speak."

Space is after all "our habitat" and "our body is the central reference point for perception" (Hornecker, 2005). Some scholars link this bodily experience of being present to social presence and define the latter either as "the degree to which a person is perceived as a 'real person' in mediated communication" (Gunawardena, 1995, p. 151), "a student's sense of belonging in a course and the ability to interact with other students and the instructor" (Picciano, 2002, p. 22), or "the ability of participants in a community of inquiry to project themselves socially and emotionally, as "real" people through the medium of communication being used" (Garrison et al., 1999, p. 94). However, as highlighted by Whiteside et al. (2017), different learners will perceive different levels of social presence even in the same environment and will correspondingly behave differently. We can therefore argue that the sense of presence entirely depends on the persons engaging in the physical, hybrid or virtual environment (Whiteside et al., 2017). On the other hand, De Caro-Barek and Støckert (2021) highlights the importance of creating digital "corridors" for social encounters in hybrid and/or fully digital spaces, like the ones that would have occurred naturally in physical spaces. Downsizing student cohorts in units of 4–5 individuals, for instance, seems to allow a more natural communication

flow and interaction and collaboration dynamics. In MCT, this approach has actively contributed to developing a higher sense of social presence and perception of learning among the students (Støckert et al., 2020a,b).

4.2.2. Technology

From our results, the technological aspect, even in the case of the complex high-end technological infrastructure that students had to deal with in the Portal, has not raised any critical issues; challenges lay more within the pedagogical domain related to communication and collaborations (as seen in the previous section on Pedagogy).

Technology has rather been a journey of discovery. Students were allowed to freely explore and seek functional/appropriate technology to support their extra needs for communication and project process management in a cross-campus setting. One student remembers: "We found out that it was also okay to use other technologies such as Discord; a very popular tool—at least for those who do gaming. So that's where it * comes * from. And then Slack to communicate. And then Google Docs, for example—where we could write together. So, we eventually found out that we had to use all these tools then, to communicate and work together. And since most or most subjects were of the type, yes, digital. Where we programmed things and stuff, we also used—a little minimal degree then, but—software to share code then for example. Well, we have GitHub for example, but we also have that kind of live sharing of code with Visual Studio Code, then."

The advanced technology infrastructure of the Portal positively contributed to students' social experience of working collaboratively. Using the technology available in the Portal daily, for hybrid meetings on campus and/or through the digital portable version of the Portal under lockdown, seemed to secure group-work progress. Technology, in this case, was crucial in supporting communication flow and more structured and productive group-work using shared project management tools. Particularly under COVID-lockdown, MCT students seem to have been better prepared to tackle the transition to fully online teaching and learning as they already were used to collaborating in hybrid and virtual learning environments.

With digitalization being a potentially disruptive force for many professions, the conceptual and practical abilities MCT students have gathered during their studies with regard to technology will also have added value for work-life post COVID, as they have been trained to solve complex problems through their complementary competencies (Bennett et al., 2020).

In general, in the hybrid setting of the cross-campus Portal, technology seemed to enable easier and useful access to competent persons for lectures and workshops off and between campuses contributing to the perception of equal distribution of pedagogical resources. It also allowed collaborations and social learning both within and outside the regular frames of the program. We can say that technology extended the physical and virtual space of the Portal and adapted to students' evolving needs. However, despite the positive implications of extending physical learning spaces/arenas through digital solutions in terms of flexibility and equality, there are few decisive factors that students point out, and that educators and learning space designers should be aware of.

Firstly, technology should serve a purpose. As one of our participants puts it, technology is good for "Exploring possibilities and limitations, what is good enough for specific needs" (ref. keystone G). In this sense, technology should be subject to pedagogical thought and action. As we already outlined in the Pedagogy section, learning activities based on students' interests and previous knowledge were more important for engagement and motivation than the technology used.

Secondly, technology cannot replace physical human interaction. As one other participant affirms "there is a big difference in unity and interaction with those who are in the same room" and "presence and involvement is easier when you participate as a physical group." Technology supported learning activities should therefore be designed with reference to this inescapable aspect of human nature as we already discussed in the Space section.

With specific regard to technological infrastructure, students remarked that upscaling of group sizes could present challenges related to the technology of how communication is experienced and takes place. Audio quality, in particular, is important for the overall user experience. Being able to hear contributors in a conversation is indeed a prerequisite for any collaboration. In larger groups, however, this aspect can be compromised as it can be difficult to trace individual sound sources when everybody is talking. There are indeed limits to what technology can do, and recent experiences gathered in various studies appropriately highlight the pitfalls of bad technological infrastructure for meaningful teaching and learning experiences (Adedoyin and Soykan, 2020; Bozkurt et al., 2020; Kim, 2020).

Building and maintaining the technological infrastructure of the Portal demanded great skills and commitment from MCT students. While all students seemed to understand the necessity of optimizing learning arenas for technical (AV) and practical purposes, not all students agreed on the level of technical completion to achieve (ref. keystone G). Many students referred to the difference between *sufficiency* versus *optimization* of solutions for communication purposes; in other words, sometimes good enough can indeed be enough. There seems to be a difference in the way students perceived technology as a learning object in itself versus technology as a medium to support teaching and learning. Once again, technology for teaching and learning should firstly play a supportive role and adapt to students' needs. As reported by Buchem et al. (2014), perceived control of intangible elements, such as planning and design, may have more positive effects on learning than control of tangible elements, such as technical tools.

Finally, a need that clearly has emerged both for students and educators in relation to digital communication in distributed learning contexts is one of digital literacy and net-etiquette (ref. keystone H); in other words, how to make students acquainted with the culture of network interaction (Shagdarova and Pavlova, 2020). One of the issues that has been reported in recent literature is *computer-mediated communication exhaustion* (Nadler, 2020), the well-known "Zoom fatigue" with related non-verbal cognitive overload (Bailenson, 2021). Another aspect with close reference to zoom fatigue is the psychological effect of *exposure stress* caused by digital meetings that many students seem to struggle with. In this case, the only solution available to the individual to retain a sense of privacy is to turn their screens black. As another participant reveals "Everyone becomes more visible, for some this can be challenging (out of comfort zone)." In the Portal, students remark that it felt more comfortable to work in small groups rather than in larger teaching settings because communication flew better, hence human interaction felt more natural. Technology was then positively used to support collaborations and knowledge sharing.

5. Final remarks and a way forward

Technology evolves in an everlasting process; what is high-end tech today it's already history tomorrow. When examining students' feedback on the Portal as a cross-campus hybrid learning and social arena, one of the most interesting findings of our research on MCT has been, unexpectedly, the relative underplayed role of technology in the bigger scene of the specific teaching and learning environment. Certainly, it is paramount to adapt the tools to the tasks - particularly when it comes to designing teaching and learning spaces, in either physical, hybrid or virtual forms. However, it is the pedagogical thought at the base of the teaching and learning design, how pedagogy materializes in flexibility and a higher sense of control for the students, that seemed to have the biggest impact on students' perception of learning, subject mastering, intrinsic motivation and, conclusively, wellbeing.

The most positive responses from the students were the ones referring to the uniqueness of the teaching and learning setting of the MCT program. The winning card of the project was the ability shown by the educators involved to *re-think teaching*. Teaching, considered as a set of methodologies and skills, is also in continuous development. The PST framework exemplarily shows this evolving process with its cradle-to-cradle design.

It is the authors' conviction that teaching and learning environments should reflect and share these mutual dynamics. Educators should exercise the same critical reflection they have on their research work also when it comes to evaluating their teaching practices and how they decide to use the learning spaces at their disposal. As Rodgers (2006) puts it:

> *"Descriptive feedback (along with other forms of description) offers a structure that disciplines one to listen to students and thereby to see them and their learning more clearly and fully, in more complex, nuanced, and differentiated ways" (pp. 232).*

We believe therefore that students' feedback is essential, and that cyclical evaluations of educators' pedagogical choices should be paramount in defining best practices in technology-enhanced learning environments in Higher Education. That is why we argue for a more prominent role of follow-up research approaches with iterative evaluation loops where both learning environments and pedagogical practices are posed to the test. We know that when students are allowed to take control and have more choices, they develop a higher sense of ownership of their learning process; and vice versa, the sense of ownership and perceived learner-control influence how students engage and develop their learning environments (Buchem et al., 2014). Mercer's social conception of cognition (Mercer, 2013) seems to leave no doubt that "[…] classroom education should provide opportunities for students to think collectively, co-constructing knowledge and understanding and solving problems collectively." Control and choice do not help if they are not relevant. Students must be allowed to manage content and methodology in current courses and to participate in the evaluation of learning cycles. Quick evaluation cycles with a faster feedback system and flexibility to influence, modify and shape courses' actual development, as it happened in the case of MCT, could be implemented as a way to make teaching and evaluation practices more transparent. It is these authors' hope that this paper might offer educators some new insights and guidelines to develop their learning environments and their teaching practices.

Figures 3A,B below are an attempt to highlight the cradle-to-cradle model of our modified PST framework including the human factor and visualize and concretize our suggestion for iterative evaluation loops applicable to learning spaces/arenas as well as to teaching and learning cycles and pedagogical practices.

The illustrations in Figures 3A,B present *a parallel circular process-oriented evaluation model.* This is an alternative to the traditional linear evaluation model for pedagogical practices that usually happens at the completion of a study program, or at the stage of post-occupancy evaluation of a learning environment (Germany, 2014) where elicited feedback is gathered from users on pros and cons about a particular learning space (Germany, 2014, p. 5).

The process-oriented evaluation loops we suggest allow instead for parallel modifications and adjustments along the way, and throughout all the phases of the cycles for both Pedagogy and Space and Technology. From the *Learning Goals and Concept* phases, which are the start of the cycle, through the *Design* phase of both pedagogical activities and learning environment, to the *Evaluation* and *Occupation/*

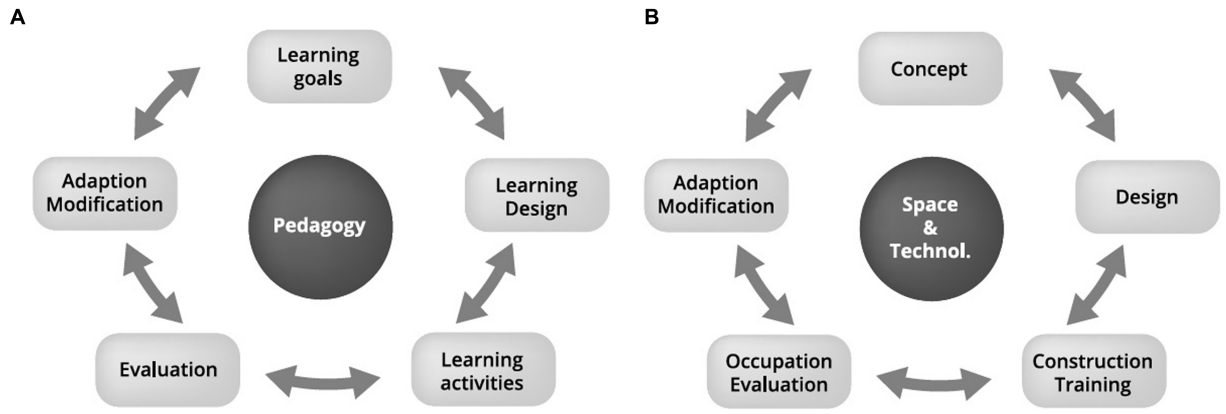

FIGURE 3
(A,B) Models for quick iterative feedback loops to evaluate learning spaces/arenas as well as learning cycles.

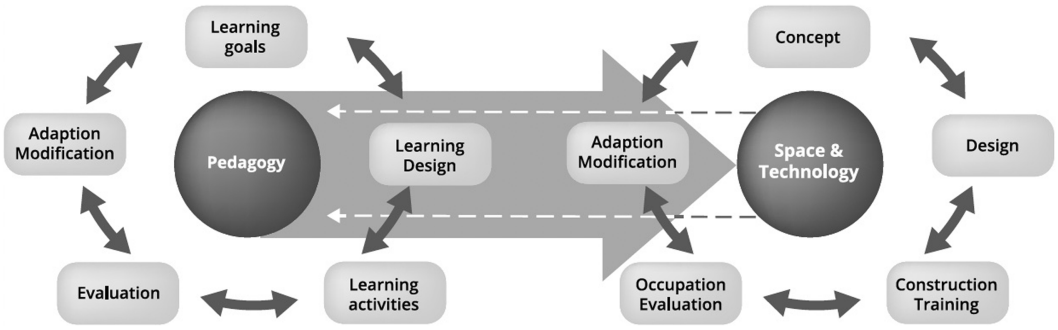

FIGURE 4
Reciprocity in the dynamics of quick iterative feedback loops to evaluate learning cycles as well as learning spaces/arenas.

Evaluation phases where feedback from users is gathered and discussed, and all the way to the Adaptation/Modification phase where adjustments take place before the cycle can start again. Also, each double arrow in the cycles represents shorter successive evaluation moments *between* phases, which can lead to positive changes in pedagogical practices and sustain a higher level of collaboration dynamics between educators and students along with the development of the cycle. In this dynamic learning environment, while it is paramount that Pedagogy informs the Space-Tech cycle, at the same time it assesses changes that might happen in the learning environment in terms of potential technology and spatial issues.

Figure 4 illustrates this reciprocity in the dynamics of the evaluation loops.

When educators and students collaborate on these iterative evaluation loops, teaching and learning dynamics develop toward a truly user-centered pedagogy. When students are actively involved in collaborations with their educators and peers, and work on learning tasks that harmonize with their personal interests and learning goals and are relevant to their future careers, they commit and build stronger ownership of the learning process itself, learning from each other and not just from their teachers. They challenge their level of knowledge but also their previous assumptions about what learning is and how knowledge occurs and develops.

We are aware that similar scenarios rarely happen in traditional teaching practices in higher education, but we believe that an action research approach to pedagogy (Altrichter et al., 2002; Runnels and O'Dwyer, 2020) for the next generation of learning spaces (Ling and Fraser, 2014), together with the experiences harvested from MCT, could serve as an example of how above- mentioned practices can evolve.

We must, however, always take into consideration the participants' level of education and personal experience when attempting to implement new pedagogical approaches. In the case of MCT, our participants were students at a master's level, and many were experienced professionals. Designing a similar program with such a degree of freedom and autonomy might pose different challenges for undergraduate students and their educators, and further research is needed on the topic.

Regardless of the study programs specificity, much of the results from our research resonates with two major systematic reviews on campus design and ICT in higher education by Lillejord et al. (2018).

It has been by far well documented that what students wish and need the most is versatility and flexibility of learning spaces and teaching forms (Lillejord et al., 2018). Students want to choose themselves when to come to campus, they also want the possibility to study wherever they are and whenever they wish so. We know students have expressed the need for learning environments as social spaces on campus, where they can both learn with their peers in small groups but also quietly by themselves. We know their preferred way of interaction is not just through oral discussions in groups, but rather through digital communication on demand, and we know they wish to be heard and not necessarily conform to what architects and educators think they know about how they should collaborate and use learning environments (Lillejord et al., 2018). We also know, paradoxically, that it is extremely difficult to put into practice what research repeatedly has been showing us (Lillejord et al., 2018). This paper hopefully can stimulate conversations in a new direction proving that it is possible to implement substantial changes in the way HE's institutions and educators relate to learning environments and teaching practices. Therefore we wish to conclude by sharing Dewey's vision for a truly progressive education where learner centeredness becomes a reality, not a mere slogan: "Education is not preparation for life; education is life itself" (Dewey, 1916). As such, learning environments and teaching and learning practices should continuously adapt to changes and be representative of learners' real-life situations and communication and interaction dynamics (Williams, 2017, pp. 92).

5.1. Limitations and future research

The purpose of this exploratory case study was to give voice to the experiences students enrolled in MCT, as a joined master's program in a cross-campus and cross-institution organization, had with regards to the specific hybrid (physical and virtual) learning environment called the Portal.

The scope of our research was an in-depth analysis of the students' experiences and evaluation of the Portal as a learning arena for student active learning and collaborations cross-campus.One aspect that might limit the current study concerns the higher level of experience and knowledge of MCT's students. Designing a similar study program with such a degree of freedom and autonomy would most likely pose other challenges for undergraduate students and their educators, and

further research is needed. It will also be advisable to investigate in more depth whether there can be a correlation between the type of the academic subject in question and the low representation of female students, as we experienced.

Another limitation to this study might be the very specificity and uniqueness of the setting. The high level of technological infrastructure displayed in the Portal is not yet the norm in university learning environments (neither physical, hybrid or fully digital), and we recognize the necessity of extending the research questions to more common cross- campus teaching and learning settings. However, teaching and learning settings such as the one described in this study can very well be actualized in the near future, and therefore our results are of relevance. Our future work as scholars, educational researchers and practitioners is to define clear guidelines for leaders and stakeholders in the HE sector. What hinder HE institutions in the implementation of genuinely sustainable and dynamic teaching and learning spaces for collaborative learning? What hinders educators in rethinking their pedagogical assumptions and teaching practices? But most importantly, what can be done about it? Why is it so difficult to counteract institutional inertia in HE (Rosenbaum, 2021)? These are the questions research needs to investigate and find answers to. By extending data gathering to other subject fields, we are in the process of collecting new information that will allow us to establish a sound background for further research.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by NSD: Norsk senter for forskningsdata. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

VC-B was the principal author and writer. DL and RS contributed to the conception and design of the study. All authors contributed to data analysis and to manuscript revision, reading, and approving the submitted version.

Funding

This manuscript was a part of the SALTO and SALTO MORTALE projects funded by the NTNU.

Acknowledgments

The authors thank the Communication Division at NTNU represented by Mads Nordtvedt for the help provided with the design of illustrations.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2023.1155374/full#supplementary-material

References

Adedoyin, O. B., and Soykan, E. (2020). Covid-19 pandemic and online learning: the challenges and opportunities. *Interact. Learn. Environ.* 31, 863–875. doi: 10.1080/10494820.2020.1813180

Ali, W. (2020). Online and remote learning in higher education institutes: a necessity in light of COVID-19 pandemic. *High. Educ. Stud.* 10, 16–25. doi: 10.5539/hes.v10n3p16

Altrichter, H., Kemmis, S., McTaggart, R., and Zuber-Skerritt, O. (2002). The concept of action research. *Learn. Organ.* 9, 125–131. doi: 10.1108/09696470210428840

Anzai, Y., and Simon, H. A. (1979). The theory of learning by doing. *Psychol. Rev.* 86, 124–140. doi: 10.1037/0033-295X.86.2.124

Baars, S., Schellings, G. L. M., Krishnamurthy, S., Joore, J. P., den Brok, P. J., and van Wesemael, P. J. V. (2021). A framework for exploration of relationship between the psychosocial and the physical learning environment. *Learn. Environ. Res.* 24, 43–69. doi: 10.1007/s10984-020-09317-y

Bailenson, J. N. (2021). Nonverbal overload: a theoretical argument for the causes of zoom fatigue. *Technol. Mind Behav* 2:1. doi: 10.1037/tmb0000030

Bennett, D., Knight, E., and Rowley, J. (2020). The role of hybrid learning spaces in enhancing higher education students' employability. *Br. J. Educ. Technol.* 51, 1188–1202. doi: 10.1111/bjet.12931

Bergmann, J., and Sams, A. (2014). *Flipped learning: gateway to student engagement*. Washington, DC: International Society for Technology in Education. Available at: https://www.readpbn.com/pdf/Flipped-Learning-Gateway-to-Student-Engagement-Sample-Pages.pdf

Blau, I., Shamir-Inbal, T., and Avdiel, O. (2020). How does the pedagogical design of a technology-enhanced collaborative academic course promote digital literacies, self-regulation, and perceived learning of students? *Internet High. Educ.* 45:100722. doi: 10.1016/j.iheduc.2019.100722

Bonwell, C. C., and Eison, J. A. (1991). *Active learning: creating excitement in the classroom*. 1991 ASHE-ERIC higher education reports ERIC. Available at: https://eric.ed.gov/?id=ED336049

Boud, D., and Cohen, R. (2014). *Peer learning in higher education: learning from and with each other*. London: Routledge.

Boys, J. (2011). *Towards creative learning spaces: re-thinking the architecture of post-compulsory education*. Routledge.

Bozkurt, A., Jung, I., Xiao, J., Vladimirschi, V., Schuwer, R., Egorov, G., et al. (2020). A global outlook to the interruption of education due to COVID-19 pandemic: navigating in a time of uncertainty and crisis. *Asian J. Dist. Educ.* 15, 1–126.

Buchem, I., Tur, G., and Hölterhof, T. (2014). Learner control in personal learning environments: a cross- cultural study. *J. Lit. Technol.* 15, 14–53.

Bulu, S. T. (2012). Place presence, social presence, co-presence, and satisfaction in virtual worlds. *Comput. Educ.* 58, 154–161. doi: 10.1016/j.compedu.2011.08.024

Casiraghi, D., Sancassani, S., Tomasini, A., Corti, P., and Brambilla, F. (2020). Il Modello Pedagogy-Space-Technology come Framework strategico a supporto dell'innovazione didattica. *Rep. E-learn. Media Educ. Meet.* 8, 64–69.

Caspi, A., and Blau, I. (2011). Collaboration and psychological ownership: how does the tension between the two influence perceived learning? *Soc. Psychol. Educ.* 14, 283–298. doi: 10.1007/s11218-010-9141-z

Charmaz, K., and Thornberg, R. (2020). The pursuit of quality in grounded theory, qualitative. *Res. Psychol.* 1, 23, 305–327. doi: 10.1080/14780887.2020.1780357

Cleveland, B., and Fisher, K. (2014). The evaluation of physical learning environments: a critical review of the literature. *Learn. Environ. Res.* 17, 1–28. doi: 10.1007/s10984-013-9149-3

Corbin, J., and Strauss, A. (2015). *Basics of qualitative research: techniques and procedures for developing grounded theory*. Thousand Oaks, CA: SAGE.

Creswell, J. W., and Poth, C. N. (2018). *Qualitative inquiry and research design: choosing among five approaches*. Thousand Oaks, CA: SAGE.

Dawley, L. (2009). Social network knowledge construction: emerging virtual world pedagogy. *Horizon* 17, 109–121. doi: 10.1108/10748120910965494

De Caro-Barek, V., and Støckert, R. (2021). From panic to planning: extending the notion of presence to create sustainable digital learning environments E-LSE -the 17th eLearning and Software for Education Conference, Bucharest.

Dewey, J. (1916). *Democracy and education by John Dewey* Project Gutenberg Available at: https://www.fulltextarchive.com/pdfs/Democracy-and-Education.pdf.

Dhawan, S. (2020). Online learning: a panacea in the time of COVID-19 crisis. *J. Educ. Technol. Syst.* 49, 5–22. doi: 10.1177/0047239520934018

Doolittle, P. E. (1997). Vygotsky's zone of proximal development as a theoretical foundation for cooperative learning. *J. Excell. Coll. Teach.* 8, 83–103.

Ellis, R. A., and Goodyear, P. (2016). Models of learning space: integrating research on space, place and learning in higher education. *Rev. Educ.* 4, 149–191. doi: 10.1002/rev3.3056

Fiock, H. (2020). Designing a community of inquiry in online courses. *Int. Rev. Res. Open Distrib. Learn.* 21, 134–152. doi: 10.19173/irrodl.v20i5.3985

Garrison, D. R., Anderson, T., and Archer, W. (1999). Critical inquiry in a text-based environment: computer conferencing in higher education. *Internet High. Educ.* 2, 87–105. doi: 10.1016/S1096-7516(00)00016-6

Germany, L. (2014). Learning space evaluations – timing, team, techniques - the future of learning and teaching in next generation learning spaces. *Int. Perspect. High. Educ. Res.* 12, 267–288. doi: 10.1108/S1479-362820140000012018

Giorgi, A. (2009). *The descriptive phenomenological method in psychology: a modified Husserlian approach*. Duquesne University Press.

Goodyear, P. (2020). Design and co-configuration for hybrid learning: theorising the practices of learning space design. *Br. J. Educ. Technol.* 51, 1045–1060. doi: 10.1111/bjet.12925

Gunawardena, C. N. (1995). Social presence theory and implications for interaction and collaborative learning in computer conferences. *Int. J. Educ. Telecommun.* 1, 147–166.

Harkavy, I., Bergan, S., Gallagher, T., and van't Land, H. (2021). Universities must help shape the post-COVID-19 world. Higher education's response to the Covid-19 pandemic: Building a more sustainable and democratic future, 25, 21. https://www.nettercenter.upenn.edu/sites/default/files/Chapter1_Harkavy_Bergan_Gallagher_vant_Land_CouncilofEurope_2021.pdf

Harviainen, J. T. (2016). Physical presence in simulation: a scratch at the surface of complexity. *Int. J. Role play.* 6, 32–38. doi: 10.33063/ijrp.vi6.244

Hilli, C., Nørgård, R. T., and Aaen, J. H. (2019). Designing hybrid learning spaces in higher education. *Dansk universitetspædagogisk tidsskr.* 14, 66–82. doi: 10.7146/dut.v14i27.112644

Hodges, C., Moore, S., Lockee, B., Trust, T., and Bond, A. (2020). The difference between emergency remote teaching and online learning. *Educ. Rev.* 27, 1–12.

Hodgson, V., McConnell, D., and Dirckinck-Holmfeld, L. (2012). *The theory, practice and pedagogy of networked learning. Chapter 17, 291-305*. New York: Springer.

Hornecker, E. (2005). Space and place–setting the stage for social interaction. Position Paper Presented at ECSCW05. Workshop: Settings for Collaboration: The Role of Place. https://www.academia.edu/1796978/Space_and_Place_setting_the_stage_for_social_interaction

Kara, H. (2020). *Creative research methods: a practical guide*. Policy Press and Bristol University Press. ISBN: 978-1447356745

Ke, F. (2010). Examining online teaching, cognitive, and social presence for adult students. *Comput. Educ.* 55, 808–820. doi: 10.1016/j.compedu.2010.03.013

Kilgore, W., and Lowenthal, P. R. (2015). *The human element MOOC: an experiment in social presence*. IGI Global: Hershey, PA.

Kim, J. (2020). Learning and teaching online during Covid-19: experiences of student teachers in an early childhood education practicum. *Inte. J. Early Childh.* 52, 145–158. doi: 10.1007/s13158-020-00272-6

Kim, J., Song, H., and Luo, W. (2016). Broadening the understanding of social presence: implications and contributions to the mediated communication and online education. *Comput. Hum. Behav.* 65, 672–679. doi: 10.1016/j.chb.2016.07.009

Lee, D., Morrone, A. S., and Siering, G. (2018). From swimming pool to collaborative learning studio: pedagogy, space, and technology in a large active learning classroom. *Educ. Technol. Res. Dev.* 66, 95–127. doi: 10.1007/s11423-017-9550-1

Leijon, M., and Tieva, Å. (2021). *Framtidens lärandemiljöer: En forskningsbaserad översikt*. Göteborg: Akademiska Hus. Available at: https://www.akademiskahus.se/globalassets/dokument/tekniska-publikationer--bilder/framtidens_larandemiljoer_rapport_2021.pdf

Levykh, M. G. (2008). The affective establishment and maintenance of Vygotsky's zone of proximal development. *Educ. Theory* 58, 83–101. doi: 10.1111/j.1741-5446.2007.00277.x

Lieberman, M. (2014) *Social: Why our brains are wired to connect*. Ney York, NY: Crown Publishers.

Lillejord, S., Børte, K., Nesje, K., and Ruud, E. (2018). Learning and teaching with technology in higher education – a systematic review. w. k. n. Knowledge Centre for Education. Available at: http://www.forskningsradet.no/siteassets/publikasjoner/1254035532334.pdf

Ling, P., and Fraser, K. (2014). Pedagogies for next generation learning spaces: theory, context, action. *Future Learn. Teach. Next Gen. Learn. Spaces* 12, 65–84. doi: 10.1108/S1479-362820140000012008

Lowell, V. L., and Campion, L. L. (2020). Introduction to TechTrends special issue: authentic learning experiences via distance learning. *TechTrends* 64, 548–549. doi: 10.1007/s11528-020-00523-2

Manciaracina, A. G. (2019). Relation among pedagogy, space and technology and users: an implementation of Radcliffe's PST framework. EDULEARN19 Proceedings - 11th International Conference on Education and New Learning Technologies, Palma, Spain, 1-3 July, 2019, IATED Academy.

Meld. St. 18 (2014-2015). *Melding til Stortinget: Konsentrasjon for kvalitet: Strukturreform i Universitets- og høyskolesektoren*. Oslo: Det kongelige Kunnskapsdepartement.

Mercer, N. (2013). The social brain, language, and goal-directive CollectivThinking: a social conception of cognition and its implications for understanding how we think, teach, and learn. *Educ. Psychol.* 48, 148–168. doi: 10.1080/00461520.2013.804394

Merleau-Ponty, M. (1945). *Phénoménologie de la perception*. Paris: Gallimard.

Merleau-Ponty, M. (2010). *Child psychology and pedagogy: the Sorbonne lectures 1949-1952*, Transl. Tania Welsh New York: Springer US.

Mirata, V., Hirt, F., Bergamin, P., and van der Westhuizen, C. (2020). Challenges and contexts in establishing adaptive learning in higher education: findings from a Delphi study. *Int. J. Educ. Technol. High. Educ.* 17:32. doi: 10.1186/s41239-020-00209-y

Mishra, L., Gupta, T., and Shree, A. (2020). Online teaching-learning in higher education during lockdown period of COVID-19 pandemic. *Int. J. Educ. Res. Open* 1:100012. doi: 10.1016/j.ijedro.2020.100012

Mizokami, S. (2018). Deep active learning from the perspective of active learning theory. *Deep Act. Learn.*, 79–91. doi: 10.1007/978-981-10-5660-4_5

Moustakas, C. E. (1994). *Phenomenological research methods*. Thousand Oaks, CA: SAGE.

Murphy, M. P. A. (2020). COVID-19 and emergency eLearning: consequences of the securitization of higher education for post-pandemic pedagogy. *Contemp. Secur. Policy* 41, 492–505. doi: 10.1080/13523260.2020.1761749

Nadler, R. (2020). Understanding "zoom fatigue": theorizing spatial dynamics as third skins in computer-mediated communication. *Comput. Compos.* 58:102613. doi: 10.1016/j.compcom.2020.102613

Ng, J. (2015). Innovating with pedagogy-space-technology (PST) framework: the online moot court. *Learn. Commun.*, 18, 52–65. doi: 10.18793/LCJ2015.18.06

NoU (2020). *Norges offentlige Utredninger*. Oslo: Departementenes sikkerhets- og serviceorganisasjon - Teknisk redaksjon.

Nowak, K., and Biocca, F. (2001). Understanding the influence of agency and anthropomorphism on copresence, social presence and physical presence with virtual humans. *Presence Teleop. Virt.* 12, 481–494. doi: 10.1162/105474603322761289

Nykvist, S. S., de Caro-Barek, V., Støckert, R., and Lysne, D. A. (2021). Key factors needed for developing a higher education cross- campus learning environment in a Nordic context. *Front. Educ.* 6:535. doi: 10.3389/feduc.2021.763761

Onyema, E. M., Eucheria, N. C., Obafemi, F. A., Sen, S., Atonye, F. G., Sharma, A., et al. (2020). Impact of coronavirus pandemic on education. *J. Educ. Pract.* 11, 108–121. doi: 10.7176/JEP/11-13-12

Oyarzun, B., Hancock, C., Salas, S., and Martin, F. (2021). Synchronous meetings, community of inquiry, COVID-19, and online graduate teacher education. *J. Digit. Learn. Teach. Educ.* 37, 111–127. doi: 10.1080/21532974.2021.1890653

Pan, X., and Zhu, L. (2020). An E-learning space for the economics experimental teaching based on pedagogy-space-technology framework. Proceedings of the 2020 International Conference on Advanced Education, Management and Information Technology (AEMIT2020). Atlantis Press. https://www.atlantis-press.com/proceedings/aemit-20/125942307

Pates, D., and Sumner, N. (2016). E-learning spaces and the digital university. *Int. J. Inform. Learn. Technol.* 33, 159–171. doi: 10.1108/IJILT-10-2015-0028

Petronzi, R., and Petronzi, D. (2020). The online and campus (OaC) model as a sustainable blended approach to teaching and learning in higher education: a response to COVID-19. *J. Pedagog. Res.* 4, 498–507. doi: 10.33902/JPR.2020064475

Picciano, A. (2002). Beyond student perceptions: issues of interaction, presence, and performance in an online course. *JALN* 6, 21–40. doi: 10.24059/olj.v6i1.1870

Polkinghorne, D. E. (1989). "Phenomenological research methods" in *Existential-phenomenological perspectives in psychology -exploring the breadth of human experience*. Eds. R. S. Valle and S. Halling (Plenum Press), 41–60.

Postholm, M. B. (2019). "Chapter 7. Analysing the data material using the constant comparative analysis method and D-analysis" in *Research and development in school: grounded in cultural-historical activity theory* (Netherlands: Brill Academic Publishers), 85–102.

Powell, D. (2008). "Evaluation and the pedagogy-space-technology framework" in *Learning spaces in higher education: positive outcomes by design: Proceedings of the next generation learning spaces 2008 colloquium*. eds. D. Radcliffe, W. Wilson, D. Powell and B. Tibbetts (St Lucia, QLD: The University of Queensland) Available at: https://static1.squarespace.com/static/55d3f590e4b0d60074069c3d/t/5cca4874c830253749556752/1556760973074/UQ+Next+Generation+Book.pdf

Radcliffe, D. F. *Creating a large, integrated and flexible engineering education research facility*. Dublin: REES (2015)

Radcliffe, D., Wilson, H., Powell, D., and Tibbetts, B. (2008). *Designing next generation places of learning: collaboration at the pedagogy-space-technology nexus*. The University of Queensland, 1–20.

Reichertz, J. (2019). Abduction: the logic of discovery of grounded theory – an updated review. *The SAGE handbook of current developments in grounded theory*, 214–228.

Rodgers, C. (2006). Attending to student voice: the impact of descriptive feedback on learning and teaching. *Curric. Inq.* 36, 209–237. doi: 10.1111/j.1467-873X.2006.0035

Rodríguez-Triana, M. J., Prieto, L. P., Ley, T., de Jong, T., and Gillet, D. (2020). Social practices in teacher knowledge creation and innovation adoption: a large-scale study in an online instructional design community for inquiry learning. *Int. J. Comput.-Support. Collab. Learn.* 15, 445–467. doi: 10.1007/s11412-020-09331-5

Rosenbaum, E. (2021). Mental models and institutional inertia. *J. Inst. Econ.*, 1–18. doi: 10.1017/S174413742100059X

Runnels, J., and O'Dwyer, F. (2020). Teacher reflections on implementing a learning cycle in EFL writing classes: an action research study. *Writ. Pedag.* 12:1. doi: 10.1558/wap.34062

Shagdarova, T., and Pavlova, S. (2020). Formation of communicative competence of students of technical university using information and communication technologies. *Sci. Technol.* 99–109.

Shearer, R. L., Aldemir, T., Hitchcock, J., Resig, J., Driver, J., and Kohler, M. (2020). What students want: a vision of a future online learning experience grounded in distance education theory. *Am. J. Dist. Educ.* 34, 36–52. doi: 10.1080/08923647.2019.1706019

Sirowy, B. (2017). *Phenomenological concepts in architecture. Toward a user-oriented practice*. [PhD thesis, Oslo, Arkitektur- og Designhøyskole - UiO]: Universitetet i Oslo.

Snoussi, T., and Radwan, A. F. (2020). Distance E-learning (DEL) and communication studies during Covid-19 pandemic. *Utopía y Praxis Latinoamericana* 25, 253–270. doi: 10.5281/zenodo.4155579

Stevenson, C. N., and Bauer, J. C. (eds.) (2020). *Enriching collaboration and communication in online learning communities*. Hershey, PA, IGI Global.

Støckert, R., Bergsland, A., Fasciani, S., and Jensenius, A. (2020a). *Student active learning in a two- campus organization*. International Scientific Conference eLearning and Software for Education. Bucharest.

Støckert, R., Bergsland, A., and Xambó, A. (2020b). "The notion of presence in a telematic cross disciplinary program for music, communication and technology" in *Music technology in education – channeling and challenging perspectives*. eds. Ø. J. Eiksund, E. Angelo and J. Knigge (Oslo: Cappelen Damm Akademisk), 77–101.

Støckert, R., Jensenius, A., Xambó, A., and Brandtsegg, Ø. (2019). A case study in learning spaces for physical-virtual two-campus interaction. *Eur. J. High. Educ. IT*. EUNIS 2019, Trondheim. https://www.eunis.org/download/2019/EUNIS_2019_paper_81.pdf

Støckert, R., and Stoica, G. A. (2017). Creating learning spaces for collaboration, communication and interaction. eLSE – 13th International Scientific Conference eLearning and Software for Education, Bucharest.

Støckert, R., and Tidemann, A. (2022). *Expanding immersive audio-based learning «IWSSIP» 29th International Conference on Systems, Signals and Image Processing. Sofia, Bulgaria.*

Stover, S., and Ziswiler, K. (2017). Impact of active learning environments on Community of Inquiry. *Int. J. Teach. Learn. High. Educ.* 29, 458–470.

Tamari, T. (2017). The phenomenology of architecture. *Body Soc.* 23, 91–95. doi: 10.1177/1357034X16676540

Tesar, M. (2020). Towards a post-Covid-19 'new normality?': physical and social distancing, the move to online and higher education. *Policy Futures Educ.* 18, 556–559. doi: 10.1177/1478210320935671

Thibodeaux, T., Harapnuik, D., and Cummings, C. (2019). Student perceptions of the influence of choice, ownership, and voice in learning and the learning environment. *Int. J. Teach. Learn. High. Educ.* 31, 50–62.

Thornberg, R. (2012). Informed grounded theory. *Scand. J. Educ. Res.* 56, 243–259. doi: 10.1080/00313831.2011.581686

Thornberg, R., and Charmaz, K. (2014). "Grounded theory and theoretical coding" in *The SAGE handbook of qualitative data analysis*. ed. U. Flick (SAGE), 153–169.

Thurston, M., and Hayes, L. (2021). *Will the 5th industrial revolution be the next renaissance?* Available at: https://www.aurecongroup.com/blog/posts/5th-industrial-revolution-next-renaissance (Accessed March 2022).

van Manen, M. (1997). *Researching lived experience: human science for an action sensitive pedagogy. 2nd edn*. Routledge: Althouse Press.

Westwood, P. (2018). *Inclusive and adaptive teaching: Meeting the challenge of diversity in the classroom*. Oaks: Routledge.

Whiteside, A. L., et al. (2017). *Social presence in online learning: multiple perspectives on practice and research*. Sterling, VA, Stylus Publishing.

Williams, M. K. (2017). John Dewey in the 21st century. *J. Inq. Act. Educ.* 9:7.

Williamson, B., Eynon, R., and Potter, J. (2020). Pandemic politics, pedagogies and practices: digital technologies and distance education during the coronavirus emergency. *Learn. Media Technol.* 45, 107–114. doi: 10.1080/17439884.2020.1761641

Xiao, J., Sun-Lin, H. Z., and Cheng, H. C. (2019). A framework of online-merge-offline (OMO) classroom for open education. *Asian Assoc. Open Univ. J.* 14, 134–146. doi: 10.1108/AAOUJ-08-2019-0033

Xiao, J., Sun-Lin, H. Z., Lin, T. H., Li, M., Pan, Z., and Cheng, H. C. (2020). What makes learners a good fit for hybrid learning? Learning competences as predictors of experience and satisfaction in hybrid learning space. *Br. J. Educ. Technol.* 51, 1203–1219. doi: 10.1111/bjet.12949

Zhan, H., Liu, Z., Lu, F., Ma, X., Zhang, S., and Chen, Y. (2020). *A construction framework design of smart classroom in universities based on pedagogy-space-technology framework*. Springer Singapore.

Zhu, M., and Basdogan, M. (2021). Examining social learning in an active learning classroom through pedagogy-space-technology framework. *J. Learn. Spaces* 10:1.