LEARNING DESIGN FOR TEACHER-STUDENT CO-AGENCY IN HYBRID SPACES

Maria Antonietta Impedovo maria-antonietta.IMPEDOVO@univ-amu.fr
ADEF, Aix-Marseille University

Seng Chee Tan Sengchee.tan@nie.edu.sg
National Institute of Education, Nanyang Technological University

Abstract

This paper reflects on hybrid learning design focusing on co-agency between teachers and students. The research question is: How could learning design with technology leverage the hybridity of the learning environment and teacher and student co-agency for post-pandemic learning? To answer this question, we examine academic publications for related studies to derive possible post-Covid learning design principles to answer the research question. Aligned with the focus of bridging hybridity, we draw on studies involving different emerging technologies from two different contexts: France and Singapore. The implications for hybridity, co-agency, and zone of possibility are analysed. The discussion stresses the virtual, material, and agentic transformation in hybrid learning design for a post-pandemic learning design.

Keywords: Emergent technology; Hybridity; Agency; Zone of Possibility; Teacher-Students

Résumé

Cet article est une réflexion sur la conception d'apprentissage hybride axée sur la co-agence entre enseignants et étudiants. La question de recherche est la suivante : comment la conception de l'apprentissage avec la technologie pourrait-elle tirer parti de l'hybridité de l'environnement d'apprentissage et de la co-agence des enseignants et des étudiants pour l'apprentissage post-pandémique ? Pour répondre à cette question, nous examinons les publications académiques pour des études connexes afin de dériver d'éventuels principes de conception d'apprentissage post-Covid pour répondre à la question de recherche. Conformément à l'objectif de bridging hybridity, nous nous appuyons sur des études impliquant différentes technologies émergentes dans deux contextes différents : la France et Singapour. Les implications pour l'hybridité, la co-agence et les zones de possibilité sont analysées. La discussion met l'accent sur la transformation virtuelle, matérielle et agentique dans la conception d'apprentissage hybride pour une conception d'apprentissage post-pandémique.

*Mots-clés :*Technologie émergente, hybridité, agence, zone de possibilité, enseignants-élèves

Note d'auteur

Toute correspondance concernant cet article doit être adressée à Maria Antonietta Impedovo maria-antonietta.IMPEDOVO@univ-amu.fr

Since 2020, the sudden disruptions imposed on the world by the Covid-19 pandemic forced all educational institutes to react urgently. The Covid-19 virus engendered, like a rhizome, the metaphoric spreading of tensions and fears across multiple cultures and settings globally. A UNESCO report estimated more than 90% of learners worldwide were affected by the pandemic. Also, according to OECD (2021), Covid-19 is not only a health crisis but also a global educational crisis, deepening the continuous learning needs. On a positive note, adopting technology accelerated by the pandemic creates opportunities for educators to examine their work and how different tools and resources can enhance learning. Discourse on technologies as a panacea to save education is rife, but these tend to focus on the availability and accessibility of networked learning or technical solutions (Dhawan, 2020).

In this paper, we view the technological acceleration triggered by Covid-19 as an invitation to the theoretical and methodological change in learning design (Laferriere & Cox, 2021), from one that focuses on mimicking in-person didactic teaching to a transformative approach where teachers and students become co-agents who creatively act, negotiate and integrate pedagogical and digital resources into meaningful learning practices. We consider how hybridity in learning can be leveraged to develop students' agency. Hybridity has been interpreted in many ways, such as blended learning (Dziuban et al., 2018) refers to learning that integrates face-to-face (synchronous) and online learning (synchronous and asynchronous) experiences in complementary service of learning objectives. The term "Hyflex" (Rodriguez & Liu, 2019), a short form for "hybrid-flexible," has recently emerged to emphasize the flexibility and choices for students to choose how they want to participate in a course or engage with materials in the mode that works best for them, either remotely or in person. In France, the expression "commodalité" (Gérin-Lajoie, Roy, & Lafleur, 2022; Gobeil-Proulx, 2019) is also used to refer to the hybridity of modalities of learning. Audio and video recording equipment in the classroom allows the session to be broadcast on the internet through a virtual classroom platform. Students, therefore, have the choice of physically showing up on campus or participating online.

The research question is: How could learning design with technology leverage the hybridity of the learning environment and teacher and student co-agency for post-pandemic learning? We examine academic publications for related studies to derive possible post-Covid learning design principles to answer this research question. Aligned with the focus of bridging hybridity, we draw on studies involving different emerging technologies from two different contexts: France and Singapore. The two contexts are selected, considering their social diversity, but mainly based on their strong involvement in teacher education and technology investments and integration in primary and secondary teaching and learning.

This intentional comparison of different contexts and technologies leverages the diversity of ideas (Scardamalia & Bereiter, 2014) to achieve a rise above robust principles that could guide our future efforts. We start with a review of the learning design with technology during Covid-19, focusing on the concept of hybridity.

Learning design with technology during Covid-19

During the Covid-19 pandemic, in different social and economic situations, teachers adapted and presented to students an urgent learning design that combined various modes of communication and interactions, simultaneously taking advantage of different technologies and applications. One of the fundamental shifts enacted by the teachers was activating the necessary

multimodality (video, pdf, chat, zoom, social networks, pictures, etc.) to strengthen communication and meaning-making with and among the students (Lim & Toh, 2022).

While the pandemic catalyzed the change, the culture and practices of learning with technologies in hybrid spaces have developed over the years. In France, during the Covid-19 pandemic, the Ministry of National Education provided teachers with numerous resources to support the implementation of pedagogical continuity for hybrid learning, all oriented to developing four main domains of knowledge: reading, writing, reasoning, and collaboration. The term "hybrid" enters into the vocabulary of teachers. In Singapore, the information and communication technology (ICT) masterplan for schools has been introduced since 1997. All teachers and students from primary to junior colleges (Grade 1 to Grade 12) have access to the Student Learning Space, a custom-built technological platform for different modes of teaching and learning, including collaborative learning and self-directed learning. Blended learning is becoming a standard mode of instruction.

Worldwide, in the face of the Covid-19 crisis, understanding the needs of teachers and students has become more salient. For instance, Yates et al. (2021) surveyed 1975 New Zealand high school students and found that space and time for learning were not the primary concern of students; instead, supportive pedagogies by teachers for students' well-being and academic progress are valued. From the survey, some students indicated their ability to leverage agency and flexibility for learning, while others lacked the necessary skills to manage their learning. Indeed, the need for students to develop agency and self-directedness in learning becomes more critical during the pandemic. In another report, Teo et al. (2021) suggested addressing three misalignments of the use of technologies for a continuation of education during Covid-19: a need to bridge learning at home and schools, the fragmentary use of technologies to simulate in-person teaching, and the disconnect between teachers' professional development with classroom practices. Building on the research finding that professional teacher engagement is related to their constructivist use of computers (Becker & Riel, 2000), post-pandemic education can provide new pieces of evidence about the need of teachers and students for learning across boundaries, like home-school, online-offline, and different modalities.

The following section focuses on how technology leverages the learning environment's hybridity for post-pandemic learning.

The spreading of the hybrid learning environment as Zone of Possibility

Before the advent of Covid-19, technologies had already been used to increasing extent and conditions for teaching and learning in many different ways, such as computerised grading; electronic textbooks (e-textbooks); computer simulation; gamification; flipped classrooms; active learning classrooms; massive open online courses (MOOCs); computer-supported collaborative learning and learning management systems (LMSs). At some point in the development and deployment of these technologies, they are known as *emerging* technologies because of the promises to impact teaching and learning significantly (LaViola et al., 2017)—usually, a novelty that must be managed and appropriate by the actors involved. For example, currently, connected objects, robotics, virtual and augmented reality, and tangible interfaces could be considered emerging technologies as they are being implemented in education, which the impact is the object of educational research (Ramlowat & Pattanayak, 2019). Evolving from the Covid 19 is the concept that enjoys newfound popularity in schools and educational research in France and Singapore: the hybridisation of learning and teaching.

According to Cook et al. (2019), hybridity combines material and digital tools that mediate an individual's interaction with the world and society. In this hybrid learning

configuration, the students interact in class and in virtual reality (with different degrees of immersiveness) or augmented reality in the hybrid digital and physical space. This liminal space supports learning through conceptual blending—multiple ideas and physical artefacts brought in by participants during their conversations (Enyedy, Danish & DeLiema, 2015). Thus, hybridity connotes the exploitation of several structures—a promising complex social space for the co-construction of knowledge through the use of material and digital tools in both physical and digital space—for learning.

The interactions of virtual and material are metaphorically referred to as "knots" (Impedovo & Gadille, 2021) to show the interweaving of virtuality and materiality: resources, modality, body, settings, resources, and the epistemic and Spatio-temporal dimensions, all closely linked to others. These knots create a zone of possibility. The concept of Zone of Possibility (ZoP), developed by Cook et al. (2020), builds on the post-Vygotsky perspectives of Daniels (2008). Vygotsky (1978) conceptualised the zone of proximal development as the space where a differential of expertise between the more knowledgeable versus the novice exists. ZoP, on the other hand, regards learners as having the capacity to inhabit a space of possibility – to enhance, augment or empower it. Thus each learner becomes a zone of socially structured possibility rather than a singular point (Daniels, 2008). In ZoP, the learners interact in a hybrid network—social, physical, and digital—and such interactions may evolve to build knowledge collectively. Thus, the ZoP may allow collective knowledge and contextual learning to emerge dynamically and jointly through equal social positioning. The zone, supported and activated by the socio-technical environment, provides the space and urges the learners to engage in the community's practices, thus allowing learners to benefit from one another. Focusing on this expanded area of possibility for teaching and learning interactions, we focus now on the agentic transformative activity that could be activated.

Co-agency in Hybrid Learning Design

Reframing the hybrid space as the ZoP connotes the concomitant reduction of expert and novice power differentials. The ZoP becomes an affordance for teachers wanting to share the responsibility with students to co-design the learning space, decide on the content, co-construct knowledge, and curate the technical tools. Students' participation in the design is seriously taken into consideration (Matusov, 2020; 2022).

The concept of agency has been regarded as a critical competency for the new generation to achieve and is also often included in policies aimed at social policy. Agency indicates the capacity of a person to act on the environment by transforming it, or proposing ideas or choices (Archer, 2000). Student's agency plays a central role in the learning process by helping the learner to find a position in and act in the world. Technology does not create forms of engaged learning or promote agency, but the design of specific activities may afford them (Tchounikine, 2019). A deep understanding of the individual and collective agency we have and will have in the future will help shape the potentiality of interactions with new and emerging technology (Castañeda, Attwell, & Dabbagh, 2023). For this reason, co-agency in the hybrid learning space is worth exploring.

The students could be recognised as co-authors of the learning space in which they participate. As Matusov (2020) argued, in conventional schools, students are often positioned to enact ready-made knowledge and skills on the teacher's demand based on pattern recognition and reproduction, rather than being the authors of their education, learning, experience, and meaning. A student's meaning-making process often involves a genuine, intentional, and information-seeking question (Matusov, 2020). While some students cannot yet deal with open-

ended questions independently, they can be presented with such a problem, no doubt they might experience a certain degree of uneasiness, curiosity, or tension. A learning environment encouraging student agency does not mean a free-for-all context void of teachers' participation and guidance. Instead, conversations between teacher and students are necessary to conduct an explicit negotiation and redefinition of shared values, and students learn how to become recognised community members. Teachers and students could be legitimate partners in the sense-making process of their roles, issues, and learning-teaching, leading to mutual transformation.

For this reason, we highlight joint teacher and student agency as the capacity of people to act upon their ideas and plans to transform current thinking or practice. Covid-19 has shown different constraints in the learning process and modality of dealing with it. We consider it promising to valorise the constraints to a full expression of a co-agency to overcome challenges in learning, such as inadequate digital skills or pedagogical knowledge, limiting technical infrastructure or connectivity, or the lack of time.

These reflections lead to how learning design could empower students and teachers, especially in a crisis. We start our reflection with two case examples below.

Case examples of learning design for co-agency in a hybrid space

In the following, two examples of learning design are presented. The first in France and the second in Singapore.

Student-teacher co-agency in sense-making (France)

One example discussed in the literature related to the introduction and regular use of Virtual-World for interdisciplinary teaching in a middle school in the French context. This experience started two years before Covid-19 and was scaled down during Covid-19 – due to the confinement. The teacher and the students from the school were familiar with the hybrid learning experiences. As described in the paper by Impedovo & Gadille (2021), the technology was successfully implemented due to the creative interdependence in the socio-technical network built around the Virtual World. All the actors - including the principal, the information technology company, technical staff, teachers, students, and ever the technology -played active and mutually supportive roles in generating scripts, creating a technical and pedagogical adaptation, and enabling flexibility in curriculum integration. The negotiation to continue translation work –as in Latour terminology (2007) – between actors (start-up, research, teachers, students, management) leads to dynamic interactions of professionals and research inquiry facilitated by the researchers working on the participative observation. Acting as the boundary objects among all the actors are the pedagogical scripts that involve both the technical and pedagogical dimensions, brought alive through the activities of the avatars and the rich articulation of concepts in a story that appealed to the sensorialities of the students, such as feeling the wave of the oceans; hearing the sounds of the nature; finding some exotic fruits in the virtual spaces and bringing in nature into the classroom during the lessons that allowed students to touch, smell and taste them.

The critical factors identified in this project were

- the building and sustaining of a learning community;
- the felt creative and safe environment, where the students had the technical capacity to build virtual objects in a pleasant, inspiring, and warm environment;

- the opportunity for teachers and students to join in the virtual learning space at school and home, either in free activity or in the form of homework.

The embodiment dimensions arise through concrete and virtual engagement in the classroom and the virtual space and show unexpected affordances, like the possibilities of challenging the psychic and physical authority of the teacher role and the sensation of being touched or pushed in the virtual space. We found teachers having difficulty with the hybrid technology management because of the tool complexity and the physical and virtual (hybridity) management. The implicit references to virtual and concrete time, space, tools, and resources must be explained in the communication to make the learning activity possible.

Student-teacher co-agency in knowledge building (Singapore)

While attempting to overcome the challenges of Covid-19 disruptions with technology-mediated learning, Teo et al. (2021) shared three misalignments in learning: the disjoint in learning between home-based learning and school-learning and across subjects, the fragmented use of technologies to simulate in-person learning, and potential disconnect between teacher's professional development and classroom practices. To tackle these misalignments, Authors (2021) created knowledge-building communities among some teachers in Singapore, who also design knowledge-building environments for their students. Knowledge building works on the premise that students can work on real authentic ideas and collaboratively improve on their ideas (Scardamalia & Bereiter, 2014). It is a foundation process and skills for creating new knowledge (to the class community), similar to how communities of scientists or researchers work at the frontier of creating new knowledge (to the world). Supporting knowledge building is Knowledge Forum, an online forum that supports the creation of knowledge artefacts and collaborative discourse to improve the artefacts.

Teo et al. (2021) reported how Jane, a science teacher, resisted using a standard video-conferencing tool to emulate in-person teaching. Instead, she used knowledge building to engage her students in tackling the real-world issue of sustainable living, focusing on the topic of vertical farming. Rather than using videos as the source of instruction, her students engaged in deep discussion about "artificial light", "light spectrum", and the use of space for vertical farming, far surpassing the prescription of the official syllabus of learning about photosynthesis.

In another school, six preschool teachers new to knowledge building formed a community as part of their professional development activity. They discussed and co-design lessons for their preschool children for topics such as "The Amazing Human Body" and "Science in Everyday Life". Rather than taking courses as professional development, the teachers co-design lessons and discuss how to support their children in knowledge building. The rich discussion and creativity in the teacher community led to innovative efforts bridging different hybridities: bringing what the children learnt at home and continue at the preschool, bringing parents into the online Forum, Chinese teacher working with an English teacher on the same topic, and using "Big ideas" to connect various topics. Even 5-year-old children showed agency in learning by initiating a movement to reduce food wastage in the preschool (Teo & Pande, 2021).

The six preschool teachers and Jane were also part of the country's teacher community, allowing teachers across levels to work with educational researchers to advance their knowledge-building practices. Viewing the overarching process at the country level forms a dual-layer structure (Tan et al., 2016): the teachers work as co-agents to advance their

professional knowledge and practices; the teachers work as co-agents with their children or students in classrooms to help advance their collective knowledge.

Common theme between the two case examples: Hybrid knowledge building configurations

Counter-intuitively, the two case examples that seem different on the surface due to the different types of emerging technologies have commonalities in the design for co-agency among participants with shared power and responsibility in a hybrid learning space, the zone of possibility. In Table 1, we summarise the two cases studies in relationship to the three main concepts evoked in the study: hybridity; zone of possibility and co-agency.

Table 1

Hybrid learning configurations in the two cases studies

	3D virtual world (e.g., Impedovo & Gadille, 2021)	Knowledge building community (e.g., Teo et al., 2021)
Hybridity	Learners and teachers navigate the hybridity in the semi-structured activity of exploration of virtual and material settings, resources, tools, and activities.	Learners and teachers navigate the hybridity of online forums and physical lessons, home-based and school-based learning, learning same topic in different languages
Zone of possibility	Learners embody creative and learning open paths in the continued exploration of the virtual and material resources, in a social and semiotic negotiation.	Learners assume collective cognitive responsibility to contribute to the collaborative improvement of collective knowledge artefacts leading to symmetric advancement of knowledge.
Co-agency	Teachers and students navigate socio-technical networks around the Virtual World pedagogical scripts: students use resources, and teachers model the semi-structured learning activities.	Students assume epistemic agency with teachers as facilitators or co-learners. Students "tinker" with ideas conceptually and sometimes physically, and teachers "tinker" with ideas on knowledge building.

From the two-case example, we can consider that designing learning tasks or knowledge-building communities in hybrid environments requires consideration for the complex orchestration between virtuality and materiality. Hybrid reality engages participants in a new embodied experience, mobilising physical and virtual engagement, spaces, and resources (Ramlowat & Pattanayak, 2019). The dual virtuality and materiality could also be experienced in 3D virtual worlds and other technology-mediated environments. For example, Knowledge Forum (Scardamalia & Berieter, 2014) is part of the design of a hybrid environment for classroom-based students to interact socially through shared digital space and experimentation or exploration in the physical space. Learners can post their ideas as digital notes (Teo et al., 2021) and may then work with physical objects (e.g., write a lesson plan and

conduct a lesson) and move back to the forum to improve their ideas. The dual virtual and physical dimension leads to a hybrid mix of resources, communication, and material dimensions.

Moreover, the use of different technologies – virtual reality in the first example, and online forum in the second example—requires a form of adaptation to using the available resources and learning with them. The interaction with the new technology is not an individual experience but is framed by the social meanings of individuals. Learning, therefore, could be considered as becoming (Lave & Wenger, 1991) with and through technology. The contextual configuration changes during the action: new semiotic fields can be brought in and old ones treated as irrelevant, adapting with the news proposes. So, the physical and virtual boundaries are not defined by reality or the virtual but co-constructed (Hirst & Vadeboncoeur, 2006). Teachers and students are involved in multiple attempts to clarify the activity and the intersubjective understanding between physical and material processes.

As an illustrative example, in this extract from a video recording of 3D virtual world avatar-mediated session in Case 1, where the math teacher was explaining the concept of angle using the virtual and material body, avatar, tools, and resources:

Extract 1:

- Math Teacher: ***Put your hands back on them and make a little space.*** *If I continue to spread, we have which angle?*
- Lilly: *Acute.*
- Math Teacher*: To do good work,* ***I propose to take the form of sheet page 33****. Do you have everything you have available* ***next to you?***
- Lilly: *Something, not all.*
- Math Teacher*:* [waiting about 30 seconds]. *Lilly,* ***do you look or not?***
- Lilly: *Ok, it is well.*

Extract 1 shows that the meaning emerges as a feature of action in situ, within the arrangements of bodies, objects, places, and environments, along with silent or talks. To be immersed in virtual reality is an experience of cognitive, emotional, and imagery involvement into a narrative.

Moreover, virtual learning, as a form of hybridity, activate a new chronotope (time and space combination) that concerns both the immaterial, semiotic worlds of discourse and narratives and patterns of organisation of space and time that are enacted through the movement of bodies, like gestures and objects (Rosborough, 2016). An illustrative example in Extract 2 is the math session of a 3D virtual world session.

Extract 2:

- Math teacher: *I'm waiting for your answer* ***now****; we are asking questions to have an answer, Michel?*
- Student: *You must click* ***on the cube*** *to see the information.*
- Math Teacher*: And what do we have for information* ***about the cube?***
- Student: *I don't know because I haven't seen it.*
- Math Teacher*: I "edit" and have information about the cube, and h****ere*** *is the information that I use. (...) I am going to question you, Tony;* ***you can lower your hand****. Are we talking about the size of....?*
- Students: *surface.*

The teacher referred to information in the temporal and spatial dimensions (in the classroom and the virtual space). Students' learning involves meaning-making in the hybrid space, interactions with the content embedded in this space, and social interactions with others.

Beyond semiotic interactions and meaning making, one crucial educational goal in the 21st century is innovativeness and the ability to create and manage new knowledge, and to handle the challenges of over-abundance of fake news and misinformation. K-12 students can be sustained in the development trajectory (knowledge building) through pedagogy such as knowledge building (Scardamalia & Bereiter, 2014). The two examples show teachers' engagement in creating and sustaining a learning or knowledge-building community where, in addition to the epistemic dimension, there are also the relational and affective dimensions for listening and welcoming. The affective dimension in learning design was significant in addressing tensions and stress during the various moments of confinement during Covid-19.

Toward a post-pandemic hybrid learning design?

Different models exist in the literature to combine activity, materiality and social dimensions in learning design. For example, Goodyear et al. (2014) and Fawns et al. (2021) discuss the design for networked learning in framing relations between participants' activities and the physical setting.

For a post-pandemic hybrid learning design, the learning design needs to consider the interconnected space between materiality and virtuality, such as how the combination of the material dimension in the classroom (tables, chairs, notebooks, overhead projector, computer) with the use of virtual or augmented reality led to a new form of configuration with a change in the way of accomplishing the task, in the organisation of resources, in the management of communicative, social and material exchanges. Students explore the physical and virtual environment to determine how they will act and learn, such as using the material resource to perform the virtual task. For this reason, the hybrid learning space is regarded as a zone of possibility. Learning design for co-agency in a hybrid space can be seen as a "social practice around ill-defined and authentic tasks or problems whose resolution requires cross-border learning that transcends disciplines, traditional structures, sectors, and forms of learning" (Cremers, et al. 2017, p. 290).

To stress the inclusion of technology in a hybrid space, thus creating a zone of possibilities, several factors could be considered:

- *Promote a distributed agency between participants interacting in the hybrid space*. We recognise the potential tensions between the teacher and students due to new forms of learning environment and the opportunities for "meta" discussion between teachers and students to make sense of the activities. The student and teachers may engage in codesigning the learning space: the learners' structure learning situations; the device presents the learning situations structured jointly by the learner and the teacher. The voices of the students, teachers, and agents involved in the learning activities are considered and expanded. At the same time, there is distributed agency among material and virtual dimensions of the learning activity, what Schraube (2009) referred to as the objectification and the materialized action of things:

> (It) is not only the subjects that do something with the things; the Things also do something with the subjects. To make it clear that on the one hand—in line with the objectification concept—human subjectivity and agency are materialised in

the object, while, on the other hand, the materiality of the object can release an independent power and efficacy, propose to conceptualise the created objects as materialised action" (p. 300).

- *Promote hybrid co-agency literacy based on zones of possibilities*: The actors in the learning space have to focus on the making something that emphasizes creative, improvisational problem-solving. Hybrid co-agency literacy means for us to active direct experience, sensor-motorial, and playful practices - stressing the challenge and the collaborative side of the interactions. To enrich the discussion, the concept of "wayfinding" is here used in a methaphoric way to shape a reflection of this literacy. For definition, it encompasses how people orient themselves in physical space and navigate from place to place. As illustrated in the example above, we consider that the students and the teachers have to introduce themselves to the new socio-material configurations. In our discourse, these conditions are proposed in a metaphoric way to the orientation of the students and the teachers between material and immaterial body like an avatar on the screen and the students in the classroom; resources like the style in the bench and the objects to build a world in a virtual setting, in extended space-time dimensions. This metaphor stresses the need for "assemblage" or arrangement necessary to move from the actual reality and, instead of reducing and seeing the moving material and semantic context unfolding into the students and teachers' interactions as "a collective arrangement of enunciation" (Deleuze & Guattari, 1975, p. 147).
- *Promote an epistemic community and affective scaffolding*: We learn in cultural and social ecologies in the spectrum of distinct groups, networks, communities, or collectives. In an inseparable part of the whole, we have access to unpredictable and fortuitous learning and knowledge sharing (Littlejohn, 2016), socially and collectively grasping meanings from engagement with materials and emerging social phenomena. In essence, epistemic cognition focuses on knowledge activities. Yet, Covid-19 shows how the learning setting became directly or indirectly the nexus of positive and negative emotions shared inside the community. The affective activation has been considered a significant response by which individuals and social groups cope with uncertainty (Proulx, 2012). The affective dimensions for reassurance and support were often implicit and needed to be explicitly activated in digital mediated learning experiences.

The co-agency in a hybrid learning environment has implications for teacher professionalisation. Indeed, the teacher has to be ready to work in a new setting that is out of their experiential spheres. In France, teacher education and professional development are related and modeled on the "teacher standard" developed and formalised in 2013, which is highly standardised and codified. Covid-19 accelerated professional development, with formal and informal short learning about technology and digital resources. The teacher standard probably has to be oriented to new paths of professionalism, allowing space to be creative and button-up and self-generated space of professional learning. For more than two decades, using technologies in teaching and learning has been a critical part of education for prospective and in-service teachers in Singapore. Yet, the Covid pandemic catalyses the transformation process by highlighting the importance of bridging the hybridity, such as online and in-person learning or school and home-based learning. Covid prompted a realisation that prolonged home-based learning may not be ideal for all, and the importance of social-emotional learning through in-person interactions cannot be ignored (Ang, 2021). An open discussion is necessary to discuss how much teacher education is open to being challenged by emergent technologies that are part of the design of hybrid learning environments.

In concrete terms, learning design is equipped with new analysis tools owing to the potential of artificial intelligence and tools for visualising real-time log data, where the possibilities of the student and teacher are enhanced. In line with Goodyear, Carvalho, et Dohn (2014), we recognise the danger of complex learning design assemblages intertwining things, tasks, and people. "If everything is connected to everything else, then where does one begin? How does one avoid an exponential growth in interdependencies?" (p. 143). As proposed by the discussion, the design is a lived experience where to find, appropriate and sustain a space of actions and possibilities, validated by real configurations and workable conditions. With this in mind, the very concept of "Learning Environments" extends beyond the computer screen or the tool. The learning space thus becomes the whole material and social context in which the same tool is used for learning purposes.

Conclusions

In this paper, we have focused on changes in learning environment design triggered by the pandemic. We consider hybrid spaces that include the material dimension (artefacts, resources, and digital and concrete tools) and the subjective dimension, linked to the power of action, motivation, and transformation. This dialectical perspective finds its synthesis in the epistemic action of learning. As proposed by Barad (2003): "the primary epistemological unit is not independent objects with inherent boundaries and properties but rather phenomena" (815). Our discussion shows the need, theoretical and methodological, to overcome duality in the conception and design for example, the cognitive and affective have to be both scaffolded; with digital tools versus without digital tools (for example, some recent experiences of learning information technology and algorithm are engaging, without completely using IT tools in different and disadvantaged contexts).

In conclusion, different concepts are mobilised to show how emerging technology could expand learning environment design. The discussion is open, but always more frequently, we see the need for an inquiry and understanding of the learning or knowledge-building phenomena in students' worldly connections, in tentacular thinking, as Haraway emphasizes (2016). The development of new learning technologies is a real and actual phenomenon. The design of learning environments with emergent technologies could increase quality if open to rhizomatic possibilities, allowing critical reflections on learning and teaching that include many issues of which we are aware or not yet at the moment - like confronting climate change, racism, gender issues, and creativity with artificial intelligence.

In short, Covid-19 has invited teachers, teacher-educators, and researchers to join in a critical reflection, hopefully creating an atmosphere that requires creative and caring contributions.

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