A tool for designing hybrid learning contexts in higher education

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Abstract. This paper investigates the opportunities offered by an instructional tool, built to help teachers in the creation of hybrid teaching activities in post-pandemic learning contexts. Teachers will design new hybrid contexts by connecting physical space, digital space, innovative pedagogical approaches and user needs. The starting points are the technical skills acquired by teachers during the period of forced distance learning, the new role of directors and designers of teaching activities assumed by teachers in active learning approaches and the need for new innovative learning environments able to relate the human and technological components. The tool, built within a PhD research, has been tested with the teachers of Politecnico di Milano in co-design and autonomous activities.

Keywords: instructional design toolkit, hybrid learning, educational technologies, innovative learning environments.

1 Introduction

The isolation imposed by the COVID-19 epidemic has forced all Italian universities to very quickly equip themselves with tools to continue their teaching activities. In a short time, all the educational institutions have tried to equip themselves with systems for distance learning. The choices made, with distinct differences from university to university, saw the rectors opting for mixed solutions, allowing synchronous and asynchronous teaching, and the use, of specific platforms for e-learning [1].

The Politecnico di Milano responded promptly to the emergency, indicating guidelines and tools for delivering online courses. A virtual classroom software has been the primary tool, used for the creation of virtual classes and starting all the courses of the second semester at a distance. It was supported by tools such as cloud drives (for file sharing and storage) and forms (for quiz creation and assessment). As the emergency became a continuing reality, pushing away the hope of quickly returning to normal, the choice to record the lessons and publish them in the web gave way to the first steps for asynchronous and blended learning.

With the arrival of the health emergency, as stated above, the Politecnico di Milano saw the necessity to start the second semester of the academic year 2019/2020 promoting distance learning. All the study courses of the Engineering, Architecture, and Design schools have thus started their teaching activities using new technological

tools and new digital environments. The Politecnico gave teachers the freedom to rethink their teaching activities to better respond to the new challenges posed by the new virtual learning environments towards shift to remote learning. It supported their creation of a repository for documents, webinars on specific topics, and provision of technological tools for online environments.

On the other hand, the Politecnico has always stressed, during the emergency, the irreplaceable value of face-to-face teaching that the University, as a place of training, relationships, and exchange, has the duty to protect. At the end of the semester, the opportunity to redesign the teaching activities for creating new hybrid learning experiences emerged.

1.1 New forms of hybrid learning

The proliferation and availability of digital tools and environments that use the connective and innovative potential of technology are radically reshaping what constitutes educational experience, where it happens, and what it means to deliver effective learning.

The expanded exposure to technology for students is questioning the status quo of education and is a direct challenge to what learning should look like in classrooms. Given this, universities must begin to expand the discourse around technology to include a debate on the development of digital learning spaces and hybrid learning processes. Such spaces will establish a more flexible environment for when and how learning will occur and will launch a conversation on what schools want to do rather than simply purchase technological tools. How these technologies support learning and communication should be a fundamental question acknowledged by all institutions.

. "Educational technology approaches evolved from early uses of teaching tools and have rapidly expanded in recent years to include such devices and approaches as mobile technologies, virtual and augmented realities, simulations and immersive environments, collaborative learning, social networking, cloud computing, flipped classrooms, and more" [2].

A reflection should be made on their choice and use in a hybrid learning environment, and some questions should be posed. Were those tools of technological communication the right ones? Did they use it in the right way? Is there a lack of trust in using tools that have not been used so much before? Conole et al. [3] pointed to a shift in the way students work, suggesting a complex interrelationship between individuals and instruments. The authors state in their conclusion that "technology is not simply seen as an 'add on' for these students, it is central to how they organise and orientate their learning". In the near future there will be the need to create new hybrid processes and to change the attributes and the requirements of the physical space: "Space is not a thing but a process" [4]. It is possible to think, reflecting on the applied research carried out, of an evolution of teaching environments in which analogical and digital, physical and intangible aspects will contribute to creating the right conditions for teachers to improve the relationships between the different actors involved in the learning process [5].

Today, the classroom has extended past four walls into what is known as "virtual space" allowing for learning to happen virtually anywhere and anytime [6]. Therefore,

space should be in charge of specific activities that cannot transcend the physicality and spatiality of a face-to-face learning relationship. Space, therefore, becomes the pivotal element for implementing essential functions that enhance both the role of the teacher and the students' activity.

In this paper, the term "hybrid learning" refers to learning that co-occurs in a physical space (on-site) and a virtual space (online) to mix and amplify the positive benefits of both contexts. These new learning experiences will soon (in a post-pandemic context) mix presence active, on-site and online activities. Space, which was a fundamental component of the educational innovation project, will regain its central role of sharing and creating educational experiences.

Hybrid learning processes happen both in physical and virtual environments. Hybrid learning environments were initially viewed as online realms that allow for synchronous and asynchronous interactive contact between teachers and learners while offering technological learning tools that learners can access at any time. This definition has recently been updated so that it can now refer to a mix of distance and face-to-face interaction in which the concept of time and the concept of virtual environment are involved.

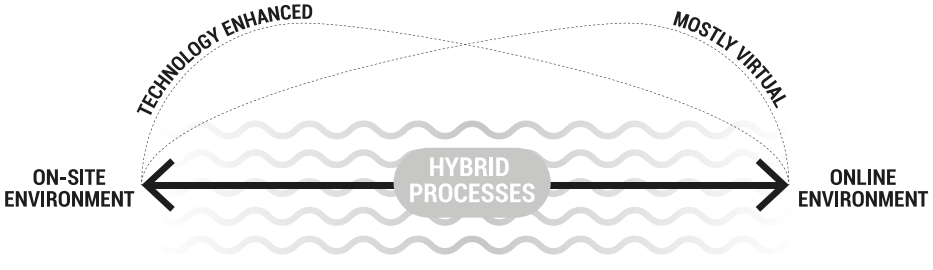

Fig. 1. The spectrum of the hybrid learning process (edited from Graham et al., 2013)

Compared to conventional learning environments, the fundamental purpose of technological tools, particularly those connected to the web, is to open up new educational possibilities found in these hybrid environments [8].

The learning environment can become a hybrid context with various degrees of technology presence, rebounding from physical to digital spaces. It is the place in which a variety of events are carried out to facilitate learning, and actors should rely on using a range of tools to do so. The fluid cycle of transition between the two environments, with the implementation of technology, is the core of why modern learning approaches continually allow us to reformulate learning, as well as why we need a system, a tool, and a set of rules, for diffuse reflection and systemic adoption.

1.2 Politecnico di Milano's learning innovation path

The theme of innovative teaching has always been central to the planning of strategic actions at the Politecnico. Already in 1991, a reflection on technological innovation in learning activities was started that formed the "Libro Azzurro" [9]. It is a report that outlines the characteristics of the experiment on innovation and computerisation of

teaching achieved through both the experiences gained individually and those promoted through initiatives of the Politecnico.

After almost 30 years and several experiments at different levels of learning, Politecnico di Milano has continued this reflection on innovation, with a three-year programme, starting in 2017, to innovate different aspects of the didactic activity.

The Politecnico has decided to carry out several works regarding infrastructure. One is the design of a series of innovative and technologically enriched learning spaces that was entrusted to a research group [5, 10, 11] of the Design Department of the Politecnico di Milano. The tool proposed in this paper has been designed within a doctoral research that focuses on the role of technologies in innovative learning environments and is inspired by the work of the research group mentioned above.

2 Designing educational activities

There is a need for a more logically coherent approach to instructional design that interrelates theory with the desired learning qualities and then maps the appropriate resources and tools. This view renders more clear the interaction between action and supporting theories and models and should encourage practitioners to make more technically informed choices about the knowledge and tools used to teach better[12].

According to Cameron, learning design "aims at providing teachers with a framework capable of bridging the gap between rich, descriptive models and technologies, and the everyday practice and understanding of teachers [13]. According to Koper [14], learning design is described: "as the application of learning design knowledge when developing a concrete unit of learning, where the quality of a unit of learning depends largely on the quality of the learning design".

Two critical issues can improve the quality of a unit of learning. On the one hand, the communication technology tools, and on the other hand, the learning design supported by proper languages and specifications can contribute to help teachers to reconsider usual teaching methods and to adopt new pedagogical approaches [15].

A learning design toolkit can embrace the use of technological tools to support the planning, the design and the delivery of learning [15].

Several institutions and researchers have provided learning design toolkit to help teachers in designing units of learning and generally the learning activities.

Fitech (a network of Finnish universities of technology) in 2019 published the "Design Book for Online learning", a tool for developing online courses, sided by a learning design toolkit. The guidebook provides hands-on tools and frameworks, especially for the creation and development of online courses [16].

Leicester University offers the 7Cs of learning design. It is a toolkit for instructors, academics, teachers, tutors and learning technologists responsible for planning, developing and teaching technology-enhanced education courses. It intends to facilitate the design of broad, engaging and pleasant education practices for students. The toolkit includes a kit of "e-tivities" (activities to be done online, or with the help of online technologies), which will support teachers to conceive engaging courses for learners in all disciplines. The kit is constructed around the 7Cs: conceptualise, capture, create, communicate, collaborate, consider and consolidate [17].

Arizona State University has designed a set of reviewed vetted resources as an essential toolkit (Design for online learning toolkit) for quality online course construction and delivery. The intent is to provide resources, steps and strategies to the agile construction of online course materials, activities and assessments [18].

The Massachusetts Institute of Technology offers the "Online Course Design Guide" to assist instructional designers and teachers in the construction and implementation of online courses. Every part of the guide includes critical knowledge, suggestions, examples, checklists, and resources for additional investigation to design and deliver significant online learning experiences [19].

However, the focus is generally on the relationship between learning units and expected outcomes, rather than on the technological tools that can activate learning practices. Moreover, the relationship between technology and physical space is often overshadowed by the possibility of designing learning activities in virtual environments, leaving aside the possibility of creating interconnections between the two types of learning environments.

3 Design tool and its elements

The provision of appropriate tools to reflect on the use of digital technology in daily practice emerges as necessary in this research. Providing a tool means that teachers have better and quicker ways to think about everyday needs and learning contexts. Learning environments represent various circumstances and backgrounds, as well as diverse participants with different positions and worldviews, mindsets and values that accompany them.

Therefore, tools to support instructional design are essential to address issues and possibilities afforded by technology. There are many reasons why teachers frequently find it hard to integrate new technology into daily practice. This view derives from the fact that several technologies were developed primarily for business and recreational purposes, and later refitted for educational purposes [20]. For teachers, this suggests some challenges:

- effort to learn using the technology in question;
- level of educational support that may be required;
- update of support, taking into consideration teacher's and students' perspective.

Teachers do not seem to be given enough assistance in tackling the core issue of their educational troubles with technologies. They should be in a position to identify and provide what is needed for their teaching activities. Learning design would be more practicable if the teacher were to be able to operate on the basis of an existing set of guidelines that discusses technological tools and helps capture and refine a specific pedagogical method and the associated learning activities and they were adopting a toolkit to plan and design the teaching activity. Teachers need an instructional tool to help them in constructing new hybrid learning processes that combine the new requirements of the physical learning spaces with the connectedness and the ubiquity of technological tools.

In order to respond to the research goals and support future steps, I conceived a co-design tool. The tool involves users in design activities throughout the design process.

The tool was built by collecting and arranging all the research's information with a clear and understandable approach. This systematisation produced an instructional design tool capable of producing several different but coherent design solutions.

The tool has graphic design types, schemes, icons, and graphic elements; it is a generative board that can give origin, through application processes, contextualisation, adaptation and reflection, to a multitude of specific outputs. The co-design tool's interdisciplinary nature catches users' knowledge and experience and brings them to conceptualisation, introducing a graphic and communication dimension that can support design innovation.

The tool places, in the early stages of testing, particular stress on participatory and co-design processes, involving the users. In fact, through a human-centred and project-based approach, it becomes:

- an instructional design tool;
- a spatial tool for concepts;
- a specific tool to identify interactions between users and technologies within an innovative learning environment.
- a specific tool to experiment with hybrid learning processes.

Therefore, the tool allows the teacher to reflect on different dimensions:

- the dimension of the user's needs;
- the temporal dimension of the educational flow;
- the educational dimension of the activities;
- the technological dimension of the instruments;
- the spatial dimension of interactions.

The tool is, then, composed of different elements, which can trigger the educational design by relating the dimensions listed above and consequently be used for reflection and discussion on the role of technologies within hybrid learning processes.

The tool does not aim to design a learning environment spatially but to deepen the relationships between two environments and relate them through technological tools. A consistent effort was made to generate graphic results of this design tool. The choice to represent the results through visual and synthetic graphic representations effectively disseminated the main features and gave rise to further reflections.

This sharing of information can help define the future steps for a conscious instructional design by all actors involved, those who will manage the course (the teachers), and the users who will be the centre of the learning activities (the students). The tool is composed of different elements, all interconnected and consequential.

Teacher's data. In this part of the tool, the teacher must enter his/her own data and those related to the course being designed.

Fig. 2. Teachers' data graphic elements

STEP 1: Activities' timeline. It consists of two parts. Through the first part, the teacher must indicate the temporal dimension of the teaching activities of a 4-hour course. The

timeline is divided into 15-minute slots to help the teacher find the right time slot. It was decided to use a 4-hour timeline as an intermediate route between 2-hour and 8-hour courses. With the second part, the teacher should begin to reflect on the use of technology by defining a technological volume (from 0 to 6) of slots previously occupied in the timeline. This last activity will be subject to continuous redefinition because it is the one that is most influenced by the reflections activated by the subsequent activities.

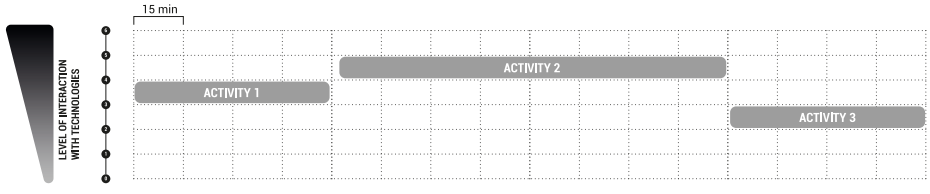

Fig. 3. Activities' timeline graphic elements

STEP 2: Users' needs. The teacher is asked to define his/her own needs and hypothesise about those of the students. The teacher reflects on the timeline created and defines the teaching needs that develop over time. This is to put users at the centre of the design and start thinking about how technologies can meet their needs. The definition of needs also serves to begin a first reflection on the interactions between users and technologies.

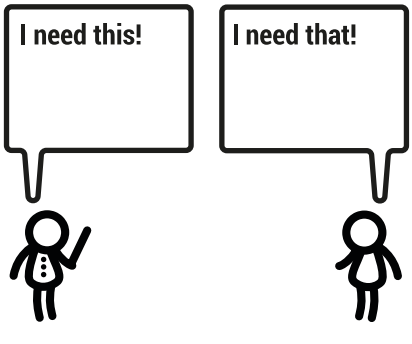

Fig. 4. Users' needs graphic elements

STEP 3: Teaching clusters. In this section of the tool, the teacher has to define the teaching clusters from their own course design experience.

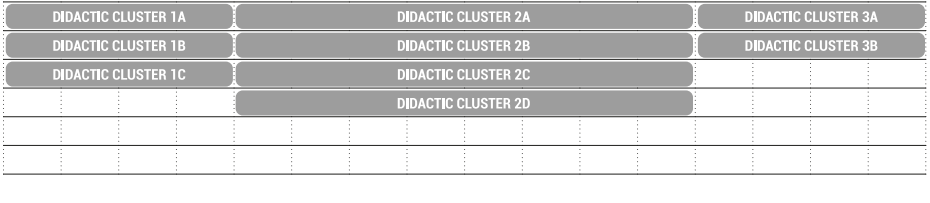

Fig. 5. Teaching clusters graphic elements

The clusters are the expression of the activities inserted in the timeline. For example, a 2-hour teaching activity can be composed of several teaching clusters: a frontal lesson can consist of a lecture associated with assessment or Q&A moments or other additional clusters.

STEP 4: Technological clusters. The teacher is given twelve cards representing the proposed technologies. They are plausible technologies, defined through research actions, and currently used in both polytechnic and international technological spaces. The classification of the technological tools results from all the reviews, observations, experiences and design actions carried out during the research activities. The selection of the technologies has been made, taking into consideration those used in different contexts, learning environments and experimentations. Table 2 defines technologies identified within each research activity carried out. At the top of the table, there are technologies that belong mainly to an "on-site" context and are easily accessible and usable in a physical environment. At the bottom of the table, there are technologies that belong mainly to an "online" context and that are easily accessible and usable in a virtual environment. In the middle, there are personal devices (smartphone, laptop, tablet, …) that are a sort of bridge between the two contexts. Mobile devices have now become sufficiently advanced technologically that they have been called thought-making machines [21] and the "Swiss army knife" [22] of the twenty-first century with the strength lying in their portability, convenience and pervasiveness [23].

Table 1. 12 defined technologies for hybrid learning environments

TOOL	DESCRIPTION	ADVANTAGES	DISADVANTAGES	APPLICATIONS
Digital Smartboard	Large interactive touchscreen connected to the web and equipped with different applications. Special pens are included to make writing in different colours quick and easy	Encourages collaboration Reduces formality in communication Allows direct interaction with data Usable as small projection Fosters interaction	Low number of users at the same time Constrained to electric current (not easily movable) Interaction dependent on installed software	Collaboration on group projects Brainstorming activities Class presentations Assignments
Analogic Smartboard	Large whiteboard connected to the web capable of digitising written content and sharing it on the cloud	Encourages collaboration Usable as a normal whiteboard Allows quick sharing of information Reduces the psychological barrier	Low number of users at the same time Constrained to electric current (not easily movable) Limited interaction	Collaboration on group projects Brainstorming activities Quick notes from the lesson Assignments
Smart Projection	Projection that allow wireless connections with mobile devices, home networks, and content	Allows all the users to share information with the class Flexible use	Sometimes problematic connection Subject to ambient light conditions	Projects presentations Frontal lesson Lesson construction with students Assessment
Video-conference System	System between two or more participants at different sites by using computer networks to transmit audio and video data	Encourages distance collaboration Allows interaction among physically distant different subjects	Possible poor quality of the transmission depending on the network Interaction limited to a digital environment	Collaboration on group projects Lectures Project discussion Assignments

Smart camera System	System that, following the users, records the activities, publishes the video online and creates recordings for asynchronous learning	Allows blended learning activities Creates repositories of learning contents Flexibility in the chosen content (user or activity) to be recorded	The set-ups are limited Possible poor quality of the transmission depending on the network	Lesson construction with students Lectures Theoretical lessons
Surface Digitaliser	Digital systems capable of transforming any wall into a touch surface through sensors and projection systems	Encourages collaboration Creates large interactive surfaces Reduces the psychological barrier	Low number of users at the same time need for complex hardware systems Limited interaction	Collaboration on group projects Immersive classroom activities Simulations Assignments Projects tests and demonstrations
Personal Device	Smartphone, tablet or laptop that easily allows connection to the web and interaction with other devices through applications	Easily transportable Ease in sharing information No psychological barriers Increases participation in lectures Multiple applications Supports searching	High possibility of distraction Too wide a variety of devices	Fast information research Collaborative activities Group project management Assignments Assessments
Student Response Software	Online software that allows teachers to create simple quizzes that students can take down quickly on laptops or their own smartphones	Provides instantaneous feedback Easy to use and access Checks the live progress of the classroom Engaged students in prompt activities Possible anonymous answers to avoid embarrassment	Analysing student data will take time Depending on the software, anonymous responses that can lead to incorrect data Need a personal device connected to internet	Polling and survey activities Lectures Theoretical lessons Flipped classroom activities Assessment
Collaborative Software	Online software that allows the collaboration through collaborative tools such as maps or workflows	Encourages collaboration Enables the easy creation of workgroup Easy translation of design processes Provides a channel for communications Supports organisation Fosters decision-making	Interaction limited to a digital environment Not suitable for large number of participants	Collaboration on group projects Project development and discussion Brainstorming activities
Cloud Software	Online software that allows the storing, sharing of files and their easy use into multiple devices	Easy to use and access Sometimes limited storage space in files dimension Limits access to specific folders Supports fieldwork	Possible slow transmission depending on the network Necessity for strict order	Collaboration on group projects Creation of knowledge repositories Assessment
Virtual Classroom Software	Online software that allows the creation of virtual environments for delivering courses and carrying out teaching activities	Supports distance education Easy to use and access Adapted for massive courses Accessible with personal devices Develops sense of learning spaces	Limitation in translation of face-to-face learning activities Limitations in learning activities Possible poor quality of the transmission depending on the network	Distance learning Virtual environments for collaboration Collaboration on group projects Lectures Theoretical lessons Assessment

		Facilitates feedback Fosters personalised learning		
Assessment Software	Online software that allows the execution of assessments and exams in virtual environments	Easy creation of tests Adapted for massive courses Accessible with personal devices Provides transparency	Need of specific control of the students Possible problems in ending the assessment due to the network	On-distance learning Lectures Theoretical lessons Assessment

The technologies, provided to users, are represented in the form of cards so that a visual reference is always at hand.

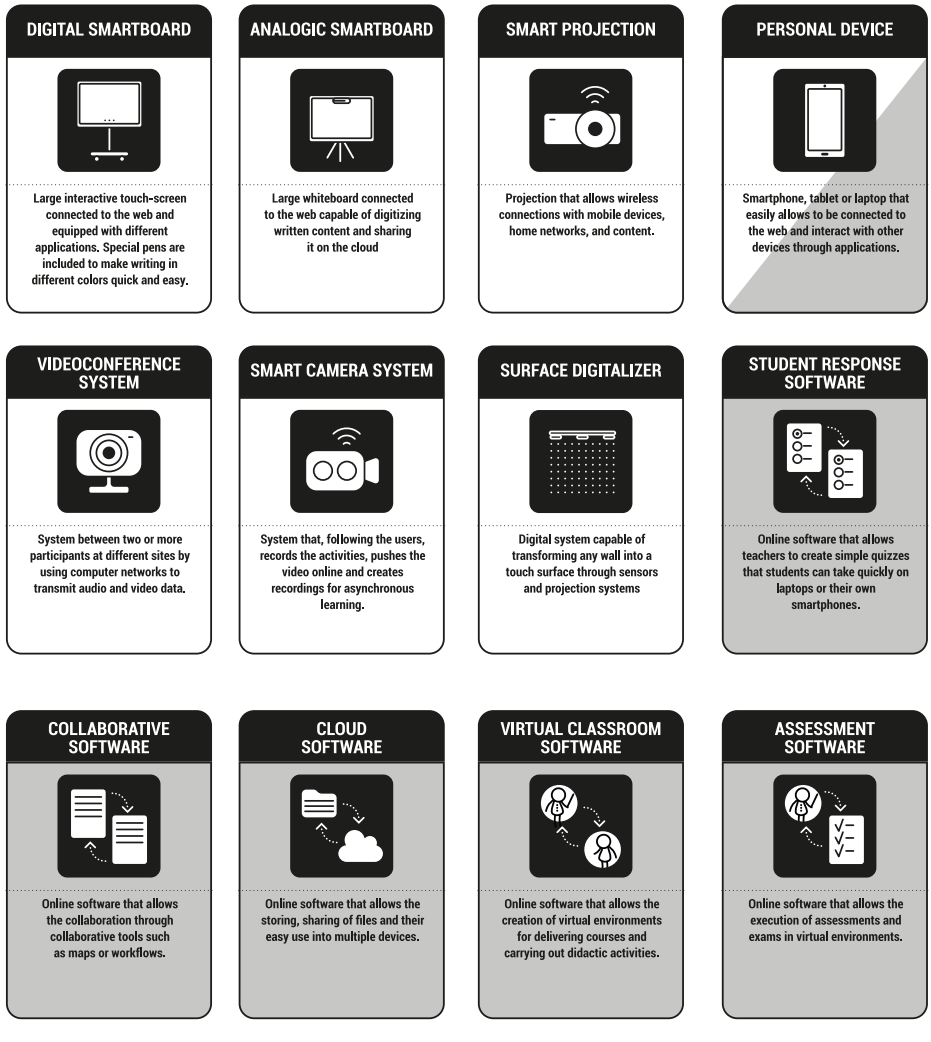

Fig. 6. Technologies' cards

The cards' function is to briefly describe the technologies and act as a mental reminder for the teacher of the various project operations. The cards are divided into two groups:

- hard technologies (with a mainly physical location within spaces)
- soft technology (with ubiquitous and mobile use).

The technology clusters are inserted from the basket of proposed technologies and should be chosen in such a way as to satisfy the implementation of the educational clusters following the needs of the users. In doing so, the reflection should focus on the relationship between user needs and technologies that can satisfy them.

TECHNOLOGICAL CLUSTER 1A	TECHNOLOGICAL CLUSTER 2A	TECHNOLOGICAL CLUSTER 3A
TECHNOLOGICAL CLUSTER 1B	TECHNOLOGICAL CLUSTER 2B	TECHNOLOGICAL CLUSTER 3B
TECHNOLOGICAL CLUSTER 1C	TECHNOLOGICAL CLUSTER 2C	TECHNOLOGICAL CLUSTER 3C
TECHNOLOGICAL CLUSTER 1D	TECHNOLOGICAL CLUSTER 2D	
	TECHNOLOGICAL CLUSTER 2E	
	TECHNOLOGICAL CLUSTER 2F	

Fig. 7. Technological clusters graphic elements

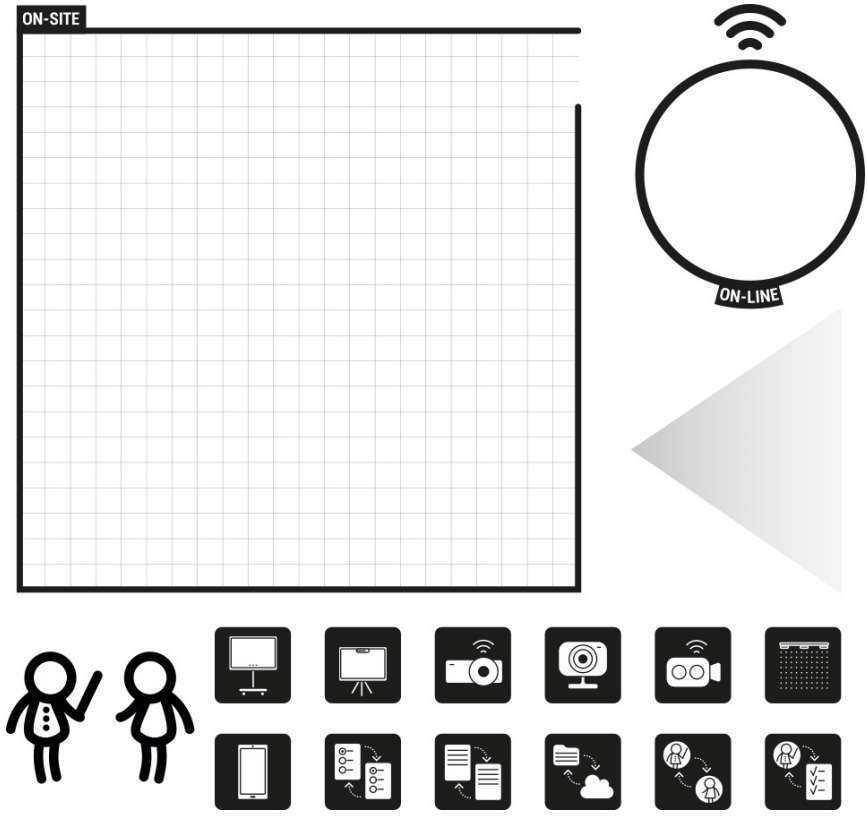

Fig. 8. Spatial set-up graphic elements

STEP 5: Spatial set-up. In this phase, the teacher realises a conceptual vision of the space, inserting users and technologies to develop relationships and opportunities visually. The teacher has at his/her disposal two graphic elements representing the two learning environments discussed in this research. He/she has to insert the symbolic elements of the technologies (technology icons), representing the users in the two spaces. He/she must then create links between the two environments to correctly indicate the technologies involved in the implementation of the activities of connection between the physical and digital world. Through the graphic visualisation of the space, the teacher can, for example, check whether the quantity of a given technology is sufficient, or determine new relationships between physical or virtual learning environments, or even define the need for new teaching clusters and, therefore, new technologies. Through this activity, the teacher connects the two learning environments (on-site and online) to think about hybrid learning processes. Through this graphic synthesis, the teacher can verify if all the users' needs have been satisfied, if the necessary technologies are present and if the teaching activities have been correctly evaluated for the "technological volume".

4 Design tool's tests

The design tool has been tested, through phases of observation, reflection and discussion, with the teachers of Politecnico di Milano, who will be involved in the next academic year, through two activities.

The first is a performative co-design activity (realized with eight selected professors of the Department of Design). The sample chosen responds to a profile of teachers between 30 and 45 years old, young enough to have a teaching perspective projected mainly into the future, but at the same time with adequate experience to build and design their teaching activity. They have been selected in such a way as to have both disciplinary variety and variety in the courses of study involved.

The second is an autonomous design activity, realized with eight professors of various departments selected through an open call addressed to the Schools of Design and Engineering.

4.1 Test 1: co-design activities

The collaborative platform chosen was Miro. Miro is a web-based platform, composed of several elements, including a digital whiteboard. Miro's primary purpose is to offer a collaborative design environment that can create mind maps and the graphical connection of inserted elements. From a graphic point of view, the great advantage of Miro is the possibility to import vector elements and preserve the quality of the inserted graphic elements. It also allows several users to interact on objects simultaneously and offers systems for recording the activities. The recordings facilitate the documentation of the design activities done with the teachers. All the teachers involved were summoned to the platform, granting them all the privileges to access and modify the elements.

Table 2. Courses involved in co-design activities

COURSE TYPE	DEGREE COURSE	COURSE TITLE	SUBJECT
Design	Offered to Product Design course	Drawing studio	Technical
Design	Offered to Product Design course	Meta-design studio	Technical
Theoretical	Offered to Communication Design course	Innovation culture and theories	Humanistic
Theoretical	Offered to Fashion Design course	History of fashion	Humanistic
Elective	Offered to all the degree courses	Materials and nanotechnology	Scientific
Design	Offered to Design & Engineering course	Product development design studio	Technical
Design	Offered to Interior Design course	Meta-design studio	Technical
Elective	Offered to all the degree courses	Software and graphic for the web	Technical

The co-design activity, lasting about 75 minutes, was divided into 3 phases:

• training: delivery of information about the general aims of the research and activity. The activity has been illustrated and contextualized within the research, emphasizing the relationship between pedagogy, space, and technology. Finally, the technologies identified and the tool's elements were described in detail;

• realisation: the teachers, who were observed step by step, were then asked to design the structure of one of their courses, to be delivered in a post-pandemic context (a context without restrictions and enriched by distance learning). They provided all the required information to be inserted and to realise the spatial concept to relate to space, users, and technologies;

• discussion: in this final phase of the project activity, the teachers expressed their views on the instrument. They were asked for a subjective judgment on the quality of the tool, its effectiveness as an instrument for reflection on the relationship between pedagogy and technology and whether they were aware of which technologies they would have wanted or could have used before using the instrument.

The teachers considered the tool as extremely useful for reflecting on the possibilities offered by technologies in the realisation of hybrid learning activities and processes. They shared the basic premise concerning the creation of spaces with comprehensive technology. In their opinion, very sophisticated technologies are suitable for very advanced learning processes and they pointed out that technologies must allow the creation of results that are available within a heterogeneous class.

Furthermore, they stated that the tool a mental reflection space they had not yet activated. They considered it “an exercise to question the didactics made forcibly at a distance” and they stressed that in the training activities on innovative teaching implemented by the Politecnico lack a design tool such as the tool used in the co-design activity. Finally, they said that the tool stimulated him to carry out an instructional design and reflection on technologies that he probably would not have carried out independently.

The performative co-design activity confirmed, then, the ability of the tool to help teachers in activating reflections on the use of technologies and their relationship with users and teaching activities. The tool proved to be able to support didactic design in hybrid contexts, and the teachers declared satisfaction in the use of the tool and the quality of the generated graphic outputs.

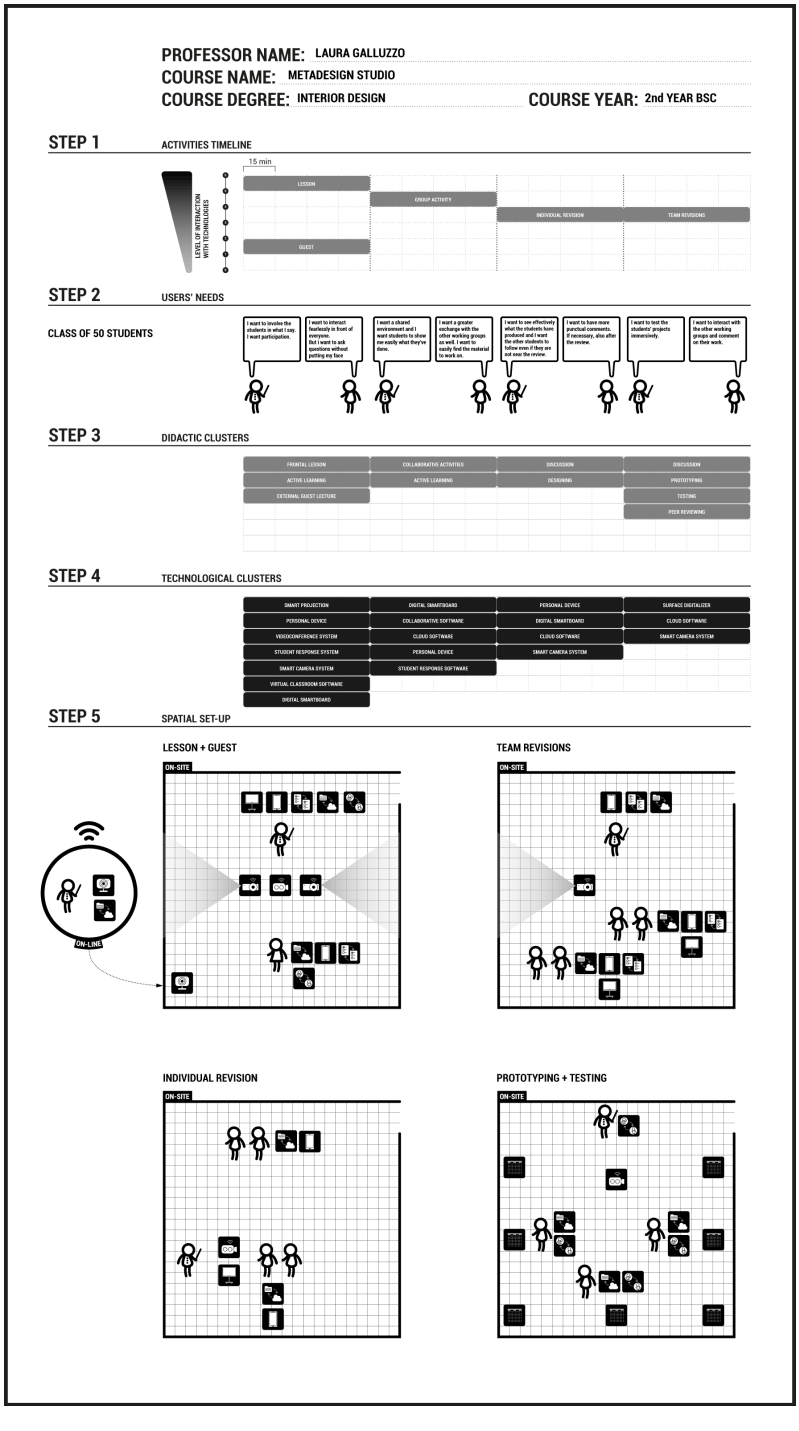

Fig. 9. The design tool (graphic output realised by prof. Galluzzo)

3.2 Test 2: autonomous activities

The next step, after the experimentation of the tool through a guided and performative co-design, is to test the tool through an autonomous design by the users. It is essential, therefore, to understand the capabilities of the tool to support teachers, when they are face to face with it and without the guidance of an expert to lead them in the design.

To understand this, a design activity, carried out autonomously by users, has been realised. For the realisation of the activity, two products have been prepared:

• instructions containing methodological information (with references to the active approach, hybrid teaching and technologies selected and used in the tool), technical information on the use of the tool (with information on the use and compilation of all components of the tool) and examples derived from the co-design activity;

• the instrument in digital PPT format containing the technological cards (visual reference always available of the selected technologies), the board and all the graphic components (icons, spatial reference, users) to the teaching design through the instrument.

The activity, composed of 3 phases, was realised in early September 2020:

• phase 1: first meeting to explain the activity on a digital meeting platform in which instructions and advice on the use of the tool were communicated;

• phase 2: carrying out the activity independently through the use of the tool in PPT format. The teachers were asked to share the graphic output they produced on a cloud folder after about three days;

• phase 3: second meeting to discuss the activity in which the graphical outputs were shown collectively, analysed and discussed to verify the understanding of the tool by teachers and their autonomy in using the tool.

The activity was attended by 8 Politecnico teachers listed in the following table.

Table 3. Courses involved in autonomous activities

DEPARTMENT	SCHOOL	COURSE TITLE
Design	Design	Trend Forecasting and Strategic Innovation
Electronics, Information and Bioengineering	Industrial and Information Engineering	Communication & Argumentation
Energy	Industrial and Information Engineering	Nuclear Engineering
Design	Design	Basics of Patternmaking and Packaging
Management, Economics and Industrial Engineering	Civil, Environmental and Land Management Engineering	Operational Management
Deng - Energy	Industrial and Information Engineering	Meta-design Studio
Architecture, Built Environment and Construction Engineering	Design	Technology Atelier
Design	Design	Final Synthesis Studio

During the discussion phase, interesting insights emerged. The teachers appreciated the graphic characteristics of the tool and its simplicity and linearity of use, praising the

presence of the cards as an element of systematisation, synthesis and visual reference of the technologies (one teacher printed them to have them always available). A teacher called it a heuristic tool that, thanks to its visual characteristics, allowed him to set new and unexpected reflections in motion. Another, evaluating the graphic and communication properties, expressed the possibility of also using the tool as a real content of the designed course, which can be used as a presentation element of the activities towards the students; in fact, he shared that the graphic output of the tool can also be of great help to the students, in understanding how (from the point of view of the organisation of activities, technologies and space) the flow of the lesson is structured and what technologies are involved for each specific activity in order to arrive prepared both methodologically and technologically.

Another starting point for reflection is the need for teachers to have ready-made examples to be used as references during their design activity. Some teachers have commented that they found it useful for the graphic outputs (generated by teachers involved in previous co-design activities of) to be included as examples in the instructions. Others admitted to take a look at the design outputs produced and uploaded to the cloud folder by colleagues. This aspect allowed them to have an immediate benchmark of adherence to the preliminary requirements of what they produced.

Some teachers suggested the possibility of creating a repository of educational clusters from which teachers, using the tool, can draw on the elements useful for building activities. This possibility had not been contemplated during the creation of the tool because the construction of the teaching activity is an operation significantly linked to the subjectivity, experience and approaches of each teacher.

However, the teachers' observation could be reflected in the future development of the tool. In the possible transition to a web-based tool, with the consequent construction of databases of information, the possibility is not to be excluded of facilitating elements in the construction and juxtaposition of teaching clusters, such as self-completion or menus able to draw on clusters already previously inserted by other users.

A further observation that refers to the greater segmentation of user needs is the same: some teachers have suggested that the presence of "pre-packaged" needs on which to reflect, would perhaps have helped them in speeding up some moments of reflection. They also indicate that it would be useful to subdivide users' needs from a pedagogical and technological point of view. This aspect could also be explored and implemented in future applications and versions of the tool.

A teacher reflected on the qualities of space and its possible transformations: “I have come to the conclusion that with such powerful means of interaction, perhaps four normal physical walls are no longer needed, but we could lecture in an open space, in a super-equipped lawn with mega interactive screens”.

We can therefore say that the activity carried out has confirmed the ability of teachers to use the tool independently and has also confirmed the ability of the tool to facilitate reflection and the creation of relationships between pedagogy, space, technology and users. It is, therefore, necessary to have a user manual dedicated to the topics dealt with and which, together with the tool, completes a toolkit of elements for teaching design in hybrid contexts.

5 Conclusions

In the weeks before the starting of the academic year 2020-2021, the Politecnico di Milano has faced the exigence of change, intervening on the technological equipment of the classrooms. The initiative has involved technological partners in the setting up of 340 classrooms located on different campuses. It is the concrete expression of Politecnico's vision of a world where digital and physical coexist and interact, to give life to quality and inclusive user experiences.

Politecnico had to envision a better future for learning activities: the health crisis has introduced new paradigms and mindsets, demonstrating the urge to design new ways of interacting, teaching and communicating. In a condition of great emergency, the sole use of digital technologies has been a great solution: practice, especially in the educational setting, has shown us that we cannot neglect a hybrid approach that incorporates physical and digital, involving more participants, so that all learners can participate actively, whether they are in a physical space or connected online.

It is not only a problem of ensuring the stability of learning for those who are unable to enter the classroom due to pandemic issues, but also of creating and introducing new forms of teaching and learning.

The paper proposes the designer's comprehensive role in reimagining the experiences of the learning environment and the design of a tool for supporting the mediating role of technologies among pedagogical approaches and users. Thus, more explicitly, design, together with its strategic thinking capabilities, supports building a foundation to introduce debates for innovating the current forms of the learning environment from a user-centric point of view.

The design tool, as the primary outcome of the research, is a tool for educational actors to start to reflect on creating new hybrid processes where the physical and digital setting in which students perform their work, including all the tools, documents, and other devices, coexist together to create a learning environment [24].

Therefore, it should be observed that the tool per se is not only an open path in innovating the existing structure of the relation between space and technology but also a direction in understanding the design perspective in the field of pedagogy. Thus, through this paper, a tool is proposed to exploit design abilities in creating responses to the experience of the learning environment in the broader field of instructional design and technologies by reimagining them as an engaging, innovative learning environment for users.

The design tool developed in this research is principally helpful in proposing critical visions into the practical difficulties and complexities involved in developing learning activities and contexts with technologies that support new learning approaches such as collaboration in mixed environments and hybrid processes.

The system in which the tool exists is currently a system that is not yet widespread and disseminated. A first future objective could be to extend the experimentation of the tool to schools of a different order and greater extent to verify its effectiveness, as well as in institutions with different learning methods and different structuring of the teaching activity. The tool has been tested in a collaborative design environment and was always tested by teachers under the supervision of the researcher. The platform used (Miro) requires a training phase for the creation of new objects and the

manipulation of existing ones. A future goal could be to create a web-based application, specifically designed to make the design and creation of outputs straightforward and simple.

Another future development, subordinate to the creation of a specific platform, could be to create a repository of outputs in order to gather a base of examples useful for the design activities of new users, and to create a sufficient number of cases to be able to extract useful data for the design of infrastructure. It seems, therefore, that there is a possibility that these research developments can help the innovation plan carried out by the Politecnico di Milano and create the basis for the evaluation or the design of both innovative learning environments and technological or methodological tools.

Considerable research remains to be fulfilled in this area, but the reflections present in the paper offer a productive starting point.

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