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University Classroom Prototypes for Innovative Learning

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Abstract: The relationship between the university and the society is a continuous exchange that never stops to influence itself, bringing benefits to both realities. Nevertheless, it is necessary to focus on the changes that can be applied in the learning field and not only on the evolution of the university system itself. The desire to refine the educational approach is an extremely current topic in the field of education. This is why, to face a series of social changes, it is fundamental to reconsider the method used to disseminate knowledge and to understand its real needs. Moreover, another element that has to be recalibrated is the lack of effective tools that are provided to students to deal with sudden changes in the business world. As a result of these transformations, the Politecnico di Milano has decided to undertake a deep revision of its didactic spaces in order to better understand the needs of all the university users and to foreshadow new scenarios that can support the evolving teaching and pedagogic methods in all the disciplines involved. The paper presents the results of a research that aims to dissert on spatial needs, potentialities, new habits and uses, and to organise all the requirements in guidelines for new learning spaces that will be firstly applied to four classroom prototypes, and then finalised and revised for a large-scale dissemination.

Keywords*: new learning models; innovative spaces and services; interdisciplinary; flexibility; customization*

1 Introduction

Like every social organism, universities have also been witnesses to a massive evolution of their structure, shaping themselves with the progression of the centuries. For De Ridder-Symoens (1992), universities have formed the new academic layer and changed the entire structure of society, enriching it and making it more complex. The global changes and the advent of elements that are breaking with the past have stimulated the creation of a vast field of study and research that is heading to new physical and conceptual frontiers. Although the main topic of research focuses on the physical design of innovative learning spaces, it is necessary to dwell on recent considerations of the role that universities play in the formation of future social class. The need to have innovative laboratories to stimulate students to gather a much wider field of information and to prepare them for the future must firstly face the relationships and gaps between universities and the business world.

Nowadays what universities are less able to transmit to students is the ability to face challenges in most of working environments, as well as the flexibility in managing multiple issues at the same time and the ability to create transversal and soft skills that can be used in multiple contexts (Morrell, 2012). This is due to the university structure itself which, on many levels, is still remarkably anchored to the past. It is therefore necessary that the educational programs of universities are able to transmit to students a wealth of skills composed by not only a competent technical and notional preparation but also a dynamic combination of cognitive and metacognitive, interpersonal, intellectual and practical skills (Haselberger, Oberhuemer, Perez, Cinque & Capasso, 2012). Fundamental changes are needed towards more personalized, social, open and dynamic learning models that can be stimulated by the design of innovative spaces (Chatti, Agustiawan, Jarke & Specht, 2010).

Designing innovative learning spaces does not only bring benefits in the sphere of academic learning but can also be extremely important for broader purposes, connected in the field of scientific research and the definition of partnerships with professional realities. In recent years there has been a flourishing birth of initiatives that are related to the creation of incubators that aim to enhance the results of academic research carried out in universities. The establishment of start-ups and spin-offs can be seen as an opportunity to promote activities and services (such as mentorships and research labs) offered by students, graduates, Ph.D. students, and academic staff to encourage the launch of new successful business initiatives and support their development (Egusa & Stunt, 2017). By creating this system, universities' potential can be extended effectively over the canonical educational role, relating more with professional realities and new dynamics thanks to reliable and innovative technology. Designing innovative spaces within the campus is therefore extremely important to allow its use by external actors, thus contributing to the creation of an integrated and mutually utilized organization between campus and city environments (Lees & Melhuish, 2015). Universities, therefore, assume even greater importance, encouraging the creation of new and productive horizons where the set of new users can move in search of new and profitable possibilities of action.

2 New Learning Models

As discussed in the previous section, universities must think about the gap between themselves and the business world, offering students more opportunities for growth in various fields. To solve this problem, the traditional didactics must incorporate new approaches to favor their insertion in a teaching path composed of new transversal and disciplinary competencies, turning the time spent in a school environment even more useful and profitable (Zanolin, 2017).

Focusing on education itself, and on the future field of the application of innovative learning methods, requires entering a system that is based on three essential elements: pedagogy, space, and technology (Radcliffe, Wilson, Powell, & Tibbetts, 2009). If the first two elements have always been put in dialogue to design an effective educational path, the last factor has been imposed with intensity only in recent times. The significant weight that technology has taken in everyday life has brought to a necessary revision of the entire learning system, making it much more dynamic and including a substantial number of useful tools and virtual layers. This new type of education, which can be collective or individual, is defined by the concept of seamless learning that is the ability to extend learning across time and locations, accessing physical and digital worlds and engaging multiple types of device to integrate different approaches to teaching and learning (Sharples et al., 2014). Also, a set of behaviours and human relationships, stimulated by the use of technology, can start a rethinking on the effectiveness of today's learning systems, thus delineating a reflection on the form and the use of spaces. In the same way, an environment, independent of its intended use, can shape people's behaviours (and therefore teaching and learning models) that tend to manifest in it (Radcliffe et al., 2009).

As far as pedagogy is concerned, it is interesting to verify how the evolution of the relationship between the primary users of the university system —both teachers and students— has changed over the centuries in a continuous relational exchange. The blended learning models used in new training offers are the result of changes in the relationships between users and a consequent shift from a passive type of teaching to an active one. The lack of effectiveness of adaptation to the new social approach shown by the passive model has encouraged a large number of teachers, scholars, and researchers to define an active learning method based on a more involved approach. The latter can be defined as "a method of learning in which students are actively or experientially involved in the learning process and where there are different levels of active learning, depending on student involvement" (Bonwell & Eison, 1991). The lesson, from a mere unique exchange of information through a single subject (the teacher) and its interlocutors (the students), takes shape on a broader opportunity of direct learning based on a set of experiences. These experiences are not only theoretical but, above all, are technical and logical and lead students to greater implementation of personal skills (Zanolin, 2017). The active acquisition takes place through discussion and collaboration, critical thinking and problem solving, and uses a wide range of tools that are not considered in a passive model. It is the action and maturation of experience that unites all types of active learning models, such as participative and cooperative learning. This hybridization of new learning systems is emerging as an incisive and more performative innovation (Christensen, Horn & Staker, 2013) but only through the stimulation of the entire sensory sector available is it possible to achieve positive and satisfactory results.

Although in Italy research on this topic is still at a particularly embryonic stage, it is a current and growing topic in various universities: meetings and seminars are organized to understand and disseminate the innovations that are most common in Anglo-Saxon contexts. In 2017, Politecnico di Milano held open training sessions for the academic staff within the Innovative Didactics Project. The seminars, diluted in five different meetings, were conducted by the delegates of education and counselling Lamberto Duò and Susanna Sancassani, the head of METID, a structure conceived with the aim of supporting the professors of the Politecnico di Milano in teaching innovation through the use of new technologies in information technology, multimedia and telecommunications. The meetings dealt with various tools and fields of application of new learning methods, from the explanation of the peculiarities of blended learning to the use of tools such as MOOCs; from the importance of implementing soft skills development to the design of courses in co-production with the world outside. The workshops were particularly involving thanks to smart tools permitting better management of time and continuous collaboration between the participants. Moreover, they have triggered a profound rethinking of current teaching investigating and clarifying the most critical points of an already anachronistic learning system, born and developed in a context that is too old to be compared to the current one.

3 Objectives

The new learning models are one of the essential components to implement an effective rethinking of the didactics. However, the different types of teaching are always in contact with a physical environment that guarantees their development and correct functioning. Although it is commonly thought that the space is only a shell that requires a series of characteristics that are purely structural to be effective, it is necessary to activate a whole rethink that includes more elements. The social context, which is much more dynamic and technologically rich, requires greater sensitivity and cognitive ability to grasp needs by turning them into physical spaces. It is no longer possible to only rely on defined design standards, but is necessary to consider new variables, in some cases poorly investigated, for a total re-planning of the dynamic and effective spaces which will motivate students in a more creative way.

What is extremely important is the awareness of the current role of users operating in an increasingly hybrid educational path. As previously investigated, active and blended learning models have decentralised the figure of the teacher in favour of a greater responsibility for students. Consequently, students are becoming the essential and generating fulcrum of space. To design an environment therefore implies a clear reflection on the behaviours and degrees of relationships that occur between the different users who live in the space. Most of the classrooms that can be seen in contemporary universities present an extremely rigid structure with almost no scope for rearrangement and improvement: spaces designed for an obsolete conception, where the spatial configuration presents a view of the teacher as the figure of primary importance. The current concept of a classroom can be reviewed as a generic learning space able to support a considerable number of behaviours and activities; we need to explore spatial alternatives to the classroom to provide a range of learning styles that link the pedagogical paradigm, its approach and its spatial archetype (Cleveland & Fisher, 2014).

One of the fundamental objectives of changing educational strategies and models is therefore the support that innovative learning environments can offer to students. Spaces can question and encourage them to become active,

independent and permanent learners inside and outside learning spaces (Moore, Fowler & Watson, 2007). Never before has there been such a gap between the use of traditional approaches to education and an increasingly rapid advancement of technology, an element that is now rooted in almost every aspect of everyday life. Classrooms must face this continuous interaction between people and spaces, adapting themselves to current needs. It is also necessary to support the design of spaces with a series of essential qualities for the correct realisation of new learning models, also relying on innovative approaches that are able to make spaces as functional as possible.

However, in the field of widespread learning, the classroom is no longer the only place to activate new learning possibilities. It is necessary to look at the university environment as a living and vibrant organism, composed of constantly moving information that flows through users, spaces and tools. This implies the awareness of all the other spaces that are potentially suitable for widespread and flexible learning: libraries, cafés, green areas and connective spaces have great design potential. Thanks to the internet, the opportunity to access information and data remotely allows to activate learning paths in any part of the campus or to define a new project field based on an interesting development. Besides configuring itself as an environment with a high degree of permeability, the space must be managed and set up for high-performance use through the insertion and use of instruments with a high degree of comfort, safety and functionality (Oblinger, 2005).

4 Class p-Prototypes for Innovative Teaching

As seen in the previous section, it seems very important for a university to start a rethink of success in terms of new social and spatial needs. This challenge of addressing the design and concept of innovative teaching and learning spaces emerges from present and future plans of the Politecnico di Milano. The university has decided to undertake a deep revision of its spaces in order to understand the needs of all the university users, and in all the disciplines involved, to foreshadow new scenarios that can support the evolving teaching and pedagogic methods.

The Politecnico di Milano has defined a general programme with these main goals for the next three years, to address the new contemporary needs on the topic by developing four prototypes of innovative university classrooms. Four spatial applications suitable for experimentation, as the test and tool for a reiterative process aiming to involve all the users in a participatory implementation of the new requirements. The experiment involves all the disciplines of the university (Engineering, Architecture, and Design) to test the innovative process in different scenarios.

Therefore, a research team of the Politecnico di Milano has been appointed to define a series of requirements and needs for the general organization of innovative teaching and learning spaces. The team has been asked to dissert on spatial needs, potentialities, new habits and uses, and organize all the requirements as guidelines to be first applied to the four classroom prototypes and then finalized and revised for a large-scale dissemination. In accepting the task, the team agreed with the goal of developing a path towards excellence along the following actions:

- acquisition of the progress of research in the sector above mentioned, deepened through the evaluation of case studies of contemporary campus projects;
- definition of requirements for designing innovative teaching activities, consisting of innovative spaces and services for learning and considering the most innovative approaches to teaching and research, with reference to the most advanced learning tools;
- development of specific guidelines to use and spread within the educational environments;
- implementation of strategic partnerships with the educational field and industry around the world for a significant social intervention;
- new interdisciplinary research lines to face emerging social challenges especially in rethinking the higher education facilities; and
- to embed scientific developments and research results into university education.

Although this paper sets out the whole research program, it will mainly focus on the first phase of the project, especially the part involving the design of a classroom of the School of Design of the Politecnico di Milano.

5 Methodology

Learning is no longer bound by classrooms, learning happens everywhere (Jackson, 2015). Rethinking educational spaces means being in tune with new needs, trends and other factors that underpin ways of experiencing the university environment. The objective of this research is to investigate these new needs from the point of view of spatial and service requirements considering new habits and new pedagogical approaches that all stakeholders face in these spaces. To meet this objective, the research team of the Politecnico di Milano has been called on by the Rector

to draw up guidelines for the preparation of classrooms dedicated to innovative teaching. Since it has been decided to adopt a user-centred method, categories of research participants have been defined to involve them in the research process (Figure 1). It is possible to divide them into four categories:

- internal actors experienced in teaching activities;
- internal actors experienced in innovative teaching;
- internal actors responsible for the maintenance of teaching spaces; and
- external actors experienced in technologies applicable to the analysed context.

As stated, the project focuses on the creation of four different learning spaces in three different discipline contexts. The first step was to analyse the different types of teaching carried out in schools to identify macro-areas of intervention on space (i.e. the disciplines of design and architecture require a distribution and a type of instrumentation different from the discipline of engineering). In order to collect as much information as possible, the research group has analysed, with the help of teaching experts, various learning behaviours implemented in various disciplines.

The next step was to meet the centres that are dealing with the didactic interaction formulated through the use of technologies, already present in the Politecnico di Milano spaces:

- the METID centre which has set up a room specially designed to test the use of technology in innovative teaching; and
- the interdepartmental laboratory EDME (Environmental Design and Multisensory Experience) that offers a physical space in which to develop and undergo experiences of digital, multimedia and multi-sensory worlds.

In these two experimentations we have been able to deal with new learning technologies such as large-scale digital smartboards and analog smartboards able to share written information in the cloud, immersive digital theatres where the user is able to make a teaching experience inside a specially created virtual set that transforms the walls of a room into touch and interactive surfaces.

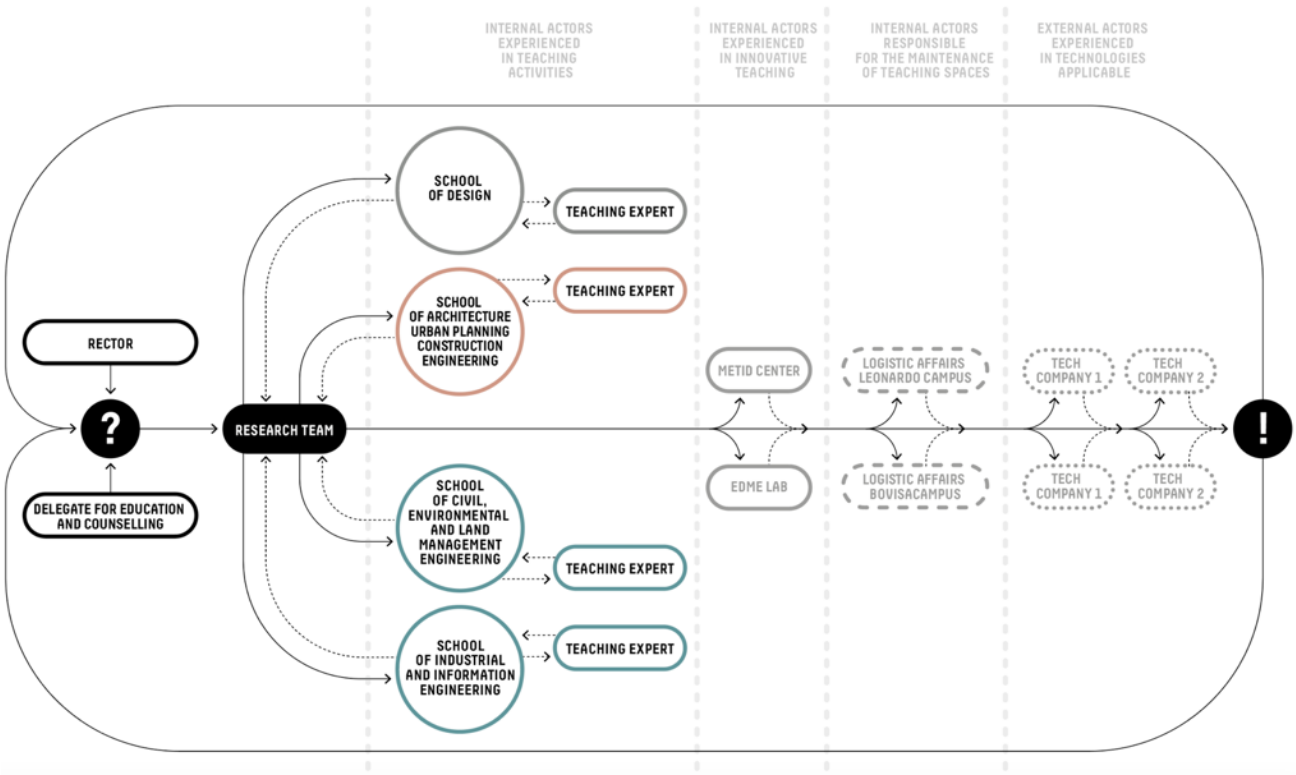

Figure 1. Map of the actors involved in the research process

After collecting the information to better assess the context, the logistics offices responsible for maintenance were involved in order to decide on the types of intervention applicable to the spaces in relation to proportions, possibility of light and sound control, position with respect to access flows and connection spaces. At the same time, technological equipment was examined to promote active learning behaviours and allow teaching activities dedicated

to the smart exchange of information and online discussions between students and distance lecturers. The last step of the process was to relate the research carried out, within a dedicated meeting, to then be able to recalibrate the interventions and reformulate research and design proposals in future actions.

6 Guidelines

Aiming to develop specific guidelines, some rules and criteria were defined to set the required elements. These were as follows.

- Flexibility: Key element and space generator for the furniture, the environmental predisposition and the management of space.
- Temporal fruition: The time factor is essential; the space must easily allow the transformation of the environment with furniture and systems that are fast and intuitive to reconfigure the space.
- Customization: Students must feel involved in the spatial context through the implementation of an interactive approach to the environment. The presence of writable surfaces, in addition to the benefit linked to learning, allows, for example, students to express their personal contact with the environment and with other students.
- Motivation: Learning spaces must be nurtured by an effective motivational level suggested through the choice of aesthetic and environmental qualities that stimulate an efficient response from the students.
- Conduct: The learning space is a public environment and is continually subject to the use of multiple users. The conformation of the structural apparatus should stimulate a correct conduct of the students for the maintenance of the provided equipment.

6.1 Parameters of the Guidelines

Since the criteria defined are linked both to the container and the content, different levels of intervention have been identified in order to satisfy the different needs. According to the main purpose of the class, a scheme of different levels of intervention and parameters that guarantee the best execution of the teaching activity was designed. The scheme (Figure 2) is built on three main elements considering the starting environment and possible hardware and software implementation:

- Base level: Comfort guaranteed from the point of view of acoustics, visual, accessibility, Wi-Fi connection, environment, energy and furniture, available in all the classrooms.
- + level: Availability of floating floor, advanced energy systems (e.g. movable plugs), sound-absorbing panels, modular furniture, writable panels, advanced audio and video systems, projection systems, smartboards, cameras, cloud.
- ++ level: Availability of specific equipment to satisfy the specific requests coming from the didactic activities carried out (e.g. equipment for online immersive learning; online video talk among students and international teachers).

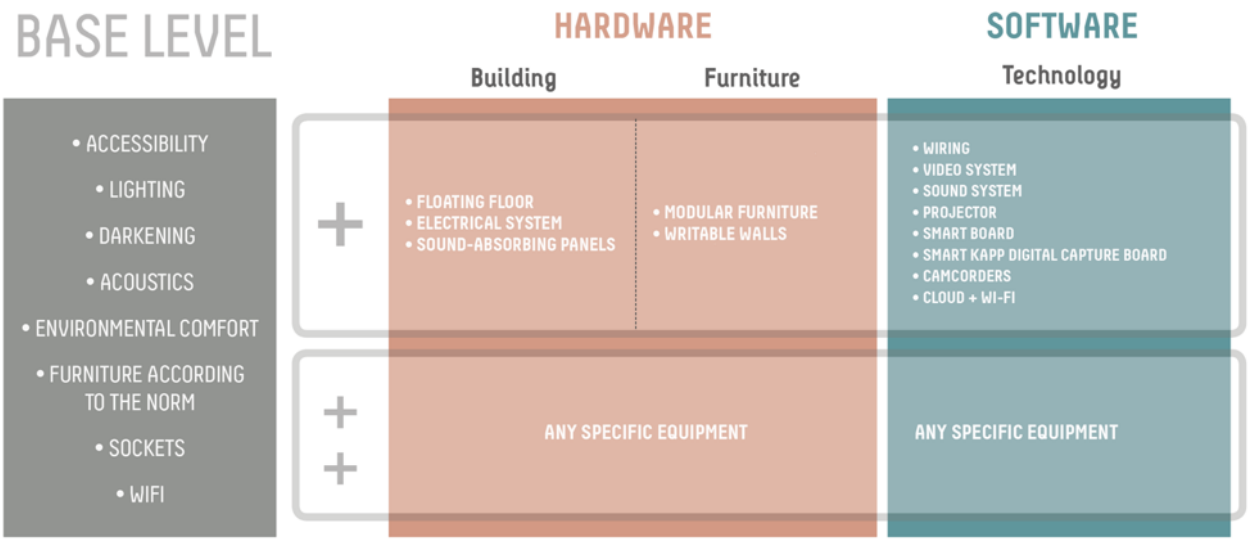

Figure 2. Diagram of the different levels of intervention

In addition to the levels identified, more connected to the physical space itself, it is important to investigate transversal parameters related to the use of the space. These parameters are useful to encourage new uses of the spaces involving new interactions between the stakeholders and new relational needs, fostering at the same time the improvement of the so-called soft skills.

These parameters have been included as:

- the creation of three main functional areas: didactic area, informal area, storage area with a ratio of 70/15/15;
- the flexibility in transforming space in the tree typologies; and
- the capability to divide space and create different compartments of use.

The didactic area, defined as the portion of space set up to support didactic action (even if of an innovative nature), is used during the time in which the structured classroom lesson (*lecture*) takes place. The informal area refers to an area with different devices that facilitate collaboration and working activities to support teaching that can be carried out at different times, in an unstructured and autonomous way compared to the teacher's action in the classroom. The storage area is the support area, container of all the elements not used in the personalization of the function performed.

6.2 Relation Between Spaces and Technologies

The choice of the technologies to implement was guided by the analysis of the types of activities and the actors using the space. On one side it was important to consider the kinds of interaction that take place between teacher and student, on the other it was necessary to evaluate the impact that technologies can have on the relations system both off-line and online (Figure 3).

The contest was analysed identifying two main didactic activities. Firstly, an activity carried out by the teacher that can be described using four different poles:

- traditional (frontal) didactic activity during which the teacher *spreads* knowledge among the students;
- collaborative didactic activity in which the teacher involves the students in the construction of knowledge;
- off-line technology; and
- online technology.

Secondly, an activity carried out by the students that can be described using four different poles:

- represented activity in which the students show the outcomes to teachers and peers, or only to peers;
- collaborative activity during which the students work among peers in the construction of knowledge and in the realization of the outcomes;
- off-line technology; and
- online technology.

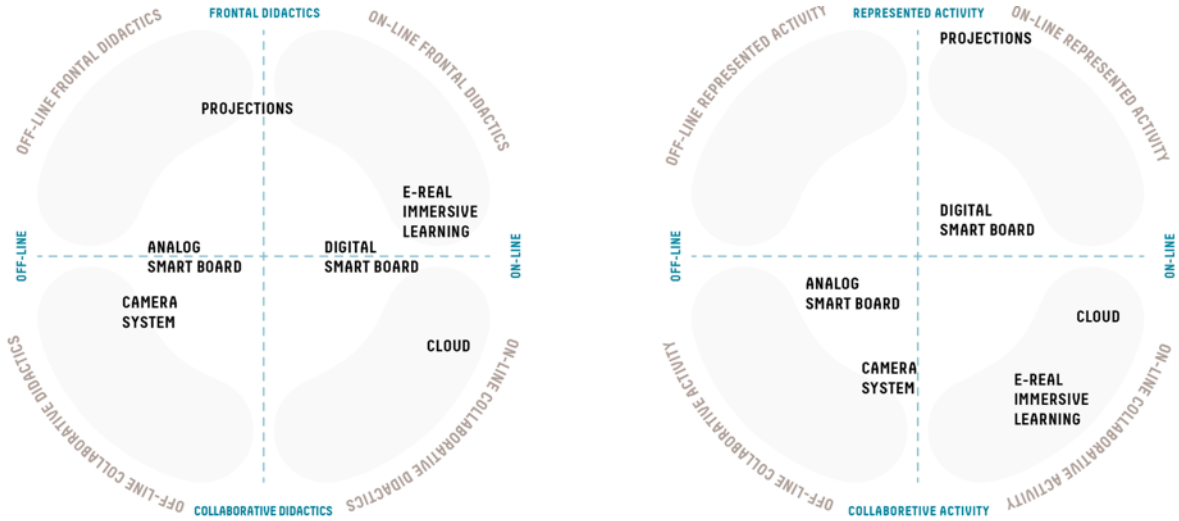

Figure 3. Diagram of the technologies dealing with the space and the people's actions

The technology used in educational spaces must therefore make a transition from a vertical technology, for teachers' needs in a confined setting, to a horizontal one, for meeting students' personal needs across multiple physical contexts (Stroup & Petrosino, 2003) (Figure 4). The students can use technology to construct their own personal way to create knowledge and learning outcomes in a proactive way, in order to reach the expected learning outcomes.

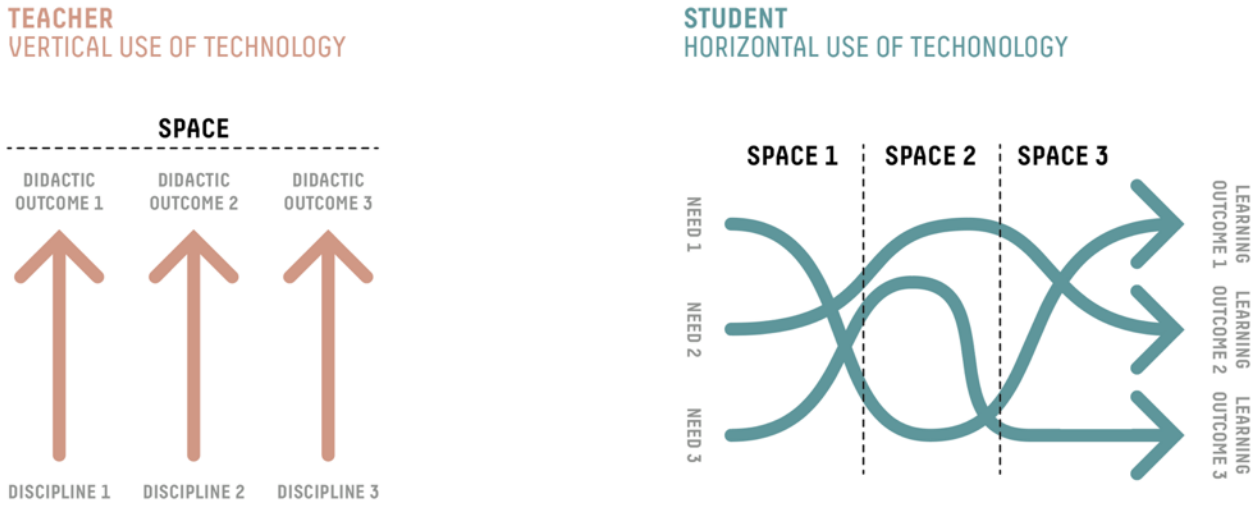

Figure 4. Vertical and horizontal use of technology

7 Discussion, Results and Next Steps

The evolution of the role of teachers and students, the innovative methods of learning and the increasingly prevalent use of new digital tools, are important signals that must first be supported by an appropriate environment, ready to stimulate the users' interest. An environment that is primarily physical but also includes a digital level that allows the creation of platforms for the exchange of knowledge and information. The research, developed through the three essential dimensions, pedagogy, space and technology (Oblinger, 2005; Radcliffe, 2009), led to a project that aims to take some time to evaluate a new teaching approach in which spaces, services and technologies stimulate a transversal and integrated learning by encouraging new types of learning pathways such as teamworking experiences, distance learning, informal learning and learning by doing. In particular, the classroom designed for the Design School illustrated in the paper is a prototype that will be tested during an entire academic year to deeply and better understand the potentialities of the various solutions that may be used. These solutions, depending on the type of teaching and learning activities that will be implemented in the educational journey, will facilitate an increasingly fluid and innovative way of doing didactics. By monitoring the behaviours and the uses of the different actors involved, it will be possible to deduce which solutions could be better applied and implemented to all future classrooms, making clear which typology of teaching and learning path would be reserved to specific cases. The first prototype of the new classroom is currently under development and it will be inaugurated in September 2019 in the Bovisa's Campus of the Politecnico di Milano. The learning space, equipped with most of the hardware and software implementations described in the paper, will be able to concretely test the levels of interaction between actors, spaces and technologies by evaluating how these last two variables could be used and mixed together to activate and balance different types of relationships between users. Moreover, a continuous planning of the learning space, and the realization of other prototypes in different university contexts, will support both consolidated design solutions and elements of experimentation, still following the typical user-centred approach of the design project.

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