INTED 2019

13th International Technology, Education and Development Conference

11-13 March, 2019
Valencia (Spain)

CONFERENCE PROCEEDINGS

Exploring New Frontiers in Education

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Published by
IATED Academy
iated.org

INTED2019 Proceedings
13th International Technology, Education and Development Conference
March 11th-13th, 2019 — Valencia, Spain

Edited by
L. Gómez Chova, A. López Martínez, I. Candel Torres
IATED Academy

DOI: 10.21125/inted.2019
ISBN: 978-84-09-08619-1
ISSN: 2340-1079
Depósito Legal: V-247-2019

Book cover designed by
J.L. Bernat

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DESIGNING INNOVATIVE LEARNING EXPERIENCES. AN EXPERIMENTAL PROJECT TO SUPPORT EDUCATION FACILITIES

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Abstract

The new learning models, in continuous updating and development, are one of the fundamental coordinates leading to further reflections on the future of teaching. These are new pedagogical approaches of the "active learning" strand that aim at teaching-learning to promote greater effectiveness and efficiency in achieving the expected learning outcomes (i.e.Biggs' Constructive alignment, Kolb's Learning Cycle, Bandura's Social Learning, Bloom's taxonomy ad Dale's cone..),with the maximum involvement of all the actors. The desire to stimulate the implementation of active and participative teaching needs, however, a new reflection on the spatial environment in which it is located and that should support the students, facilitating the process of involvement, participation, comparison enhancing their creativity and encouraging the development of their "soft skills". Environments that can guarantee: motivation, flexibility, personalization, collaboration and good behaviours.

The lack of suitable spaces arranged for this ductility automatically disadvantages the correct execution of teaching, always linked to a more traditional and passive conception. Accordingly, colleges and universities around the world are facing the challenges of rethinking higher education facilities to respond to the emerging needs and these significant changes dealing with teaching activities facing future trends.

One of the answers is the use of technology that can perform several key functions in the change process, including opening up new opportunities that improve teaching and learning particularly with the affordance of customization of learning to individual learner needs, which is highly supported by the learning sciences [1]. The technology used in educational spaces must, therefore, make a transition from vertical technology (for teacher's needs in a confined setting) to horizontal technology (for meeting students' personal needs across multiple physical contexts) [2].

This paper focuses on the evolving requirements of learning spaces to become spatial supports able to make the lecture a learning experience developed by a network of people, a construction, and sharing of knowledge as a summation of the individuals involved through the use of innovative technology for learning. It will attempt to test within an existing campus: the Politecnico di Milano (Italy). The specific aim of this work is to present the emerging spatial needs due to the changes cited above, in order to support the active learning process, and test them with participatory activities, addressed both to academic staff and students.

The expected results aim at a rethinking of the spatial model that allows supporting in the classroom this continuous mechanism of interaction between people and space, molding to the current needs, creating and encouraging the highest possible number of connections between the different actors present in the classroom. The final outputs are Learning space prototypes as a reflection of the university environment as an alive and vibrant organism, composed of constantly moving information flows through the actors, the spaces, and supports for a 360-degree performing use, able to reach a very high educational impact.

Keywords: Learning Environments, Technology for learning, Higher Education Facilities, Collaborative, Spatial design.

1 INTRODUCTION

The effectiveness of universities is based on the balance of three main essential elements: *pedagogy*, *space,* and *technology* [3]. These components of primary importance constitute a complex organism suitable for the formation of new capable and complete individuals, ready to face business challenges and to determine the future society's architecture. However, factors such as the emerging and continuous advancement of technology, generational renewal, and new economic and funding systems, are calling for an ever more rapid evolution of today's society. As a consequence, even

ISBN: 978-84-09-08619-1

today's higher education finds itself increasingly ineffective in carrying out its primary task of conveying knowledge for the new generations [4] and require a massive and continuous update to face the mutable surrounding reality.

In the field of university education, it is vital to keep up with the technological innovations that are increasingly taking root in today's social structure. Since the last decade of the twentieth century, the advent of technologies and the birth of the World Wide Web have triggered an unprecedented process of alteration of everyday life. The flourishing of digital tools conceived as supports in daily life has significantly changed the generations involved, offering an infinite field of application and minimizing temporal, geographical and cultural distances. As far as universities and education, in general, are concerned, it is clear that technological and digital innovations are essential for many reasons, from being physical tools for widespread information to representing a necessary basis for the creation of a knowledge society based on common acquaintance as a vital and democratic asset for global development. The technology, besides having expanded the concept of space towards the creation of a virtual environment with infinite possibilities of use and has also succeeded in supplying a series of digital devices for its correct use. It is necessary to calibrate education with the tools offered by ICTs in order to build an effective training offer based on increasingly pervasive connectivity [5].

Regarding pedagogy, it is possible to identify in technologies a supportive tool for the development and simplification of all the actions that exist between various actors in universities' spaces. First, it is essential to outline an evolutionary arc that, since the last century, has redefined the roles of the teacher and the students, allowing the latter to acquire a central role and so no longer being subordinated to the figure of the professor. This change has encouraged the development of new learning models based on an active type, that is "*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.*" [6]. The grafting of this approach, much more engaging than a passive model, has shaped the canonical lesson to be an educational moment based on the sharing of experiences and personal maturation. Students are taken on a more self-directed path in which they can develop technical and logical skills across different contexts with and without external facilitations [7]. Active learning models, such as *participative* and *cooperative learning*, allow the acquisition of knowledge and personal skills through problem-solving, discussion and collaboration between groups of individual students or even through interaction with online communities, teachers, and experts. Thanks to the combination of a more involving work and the use of increasingly high-performance digital devices, it is possible to achieve a broader and more effective degree of maturation and growth.

The research deepens the correlations between both physical and virtual spaces and new technologies to design environments in support of the already mentioned social and educational changes. The work proposed below is aimed at the development of new spaces for innovative learning activities at the Politecnico di Milano that can be formalized in hybrid and flexible space opportunities.

2 LEARNING SPACES AND TECHNOLOGY

As Groff states, while technology integration has long been a critical area of concern in education, the intersection of technology with our rapidly transforming educational landscape is framing the nature of technology in education in profound, new ways. New and emerging technologies are provoking a re-conceptualization of teaching and learning, while also serving as catalysts for transformation and innovation [8]. According to the design framework of Radcliffe [3], it seems that technology and space are part of a triptych in which all the components play a fundamental role in innovating the learning activity.

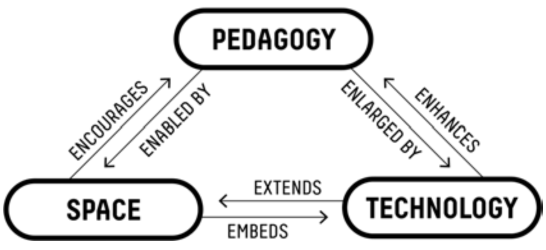

Figure 1. Pedagogy-space-technology framework [3].

When we face the intersection of pedagogy, space and technology we witness the presence of what is called a "Next Generation Learning Spaces" (NGLS) or "Future Learning Spaces" (FLS) where the three elements create the conditions for a social, collaborative and active learning in which the use of digital and technological tools (a support of the various activities) can allow the creation of different creative places within the same space [9].

Designing an innovative and technology-enriched learning space must take into consideration the relation between the space itself and the activity carried on by teachers and students through the use of technology.

Technology can help the space users to facilitate learning dynamics (take advantage of students' familiarity with technological tools to create active learning dynamics), improve space comfort (for instance through sensors that enhance the quality of sound, light and perceived temperature), extend space limits (for instance using immersive technologies that create virtual environments), maximize space usage (through the right devices for the requested task to exploit the areas in the desired ways)

Space can help technology users to make convergence between different technologies possible, find new uses for a specified technology, create new forms of interaction, improve the “state of the art” of a technological device

We are moving towards increasingly mixed, blended, virtual and real educational environments, and increasingly interactive because the experiential dimension constituted by the person-person and person-machine interaction often makes multimedia learning environments effective.

One of the main problems when using technology to support teaching, within a learning environment, is the ability of users to approach the technological devices in a natural way and without any psychological barrier.

The future technology-enriched learning space should allow multiple approaches and uses, limited only by users creativity if we take into consideration all the components (architecture, furniture, and technology).The spaces need to have “casual” and supportive technology that does not get in the way physically and does not block the normal flow of creative work.

Here is where the concept of affordance comes into play. The concept of affordance takes the definition back to Gibson [10] and Norman [11]. The affordance’s approach, useful for a technological learning environment, is focused on the relationship between the infrastructure of information and communication technologies and people’s use of those technologies [12]. Affordances are concentrated on the connection among individuals and devices or equipment, their creative and versatile cooperation with the learning space instead of any consistent reaction to any specific details of that space. Then the educational space should be designed and set up for the purpose to make the presence of devices totally merged with itself, so that the students, when engaged in using the available technological tool in order to interact with teachers’ contents or requests, should be able to naturally operate and communicate their intentions and their results without any complication. In the best possible design of learning environments, all the technological devices and equipment are fused with the traditional space, creating the conditions for a free and without limits interaction among teacher and students and students and peers.

For example, the SMART kapp 84 board enables teachers and students to collaborate with others in a simple but powerful way. The person in charge can write and draw on the board like he would on a regular dry erase board. Any other user can then connect a Bluetooth-enabled mobile device to the board by scanning a Quick Response (QR) code or by tapping the Near Field Communication (NFC) tag. At the first connection, the mobile device is directed to the Apple App Store or Google Play to download the SMART kapp app. After the app’s download and install, the mobile device can be used to connect the user to the board and to share content with others. With this kind of board, the user can naturally use his hands to create information in a common way (simply using normal pencils) but immediately the data are transferred digitally. Each participant can view all the annotations created on the Kapp board and can share and make notes directly from their device. All the work produced can be saved on a USB stick or sent directly by SMS or mail, WhatsApp or other available ways.

We can, therefore, affirm that in an evolved context, the digital world must merge with the analogical one to generate new approaches. Especially an educational system does not refer only to a pushed technological field (technology as an end in itself), but to the one where technology is one of the elements that contribute to the creation of successful academic development for effective technology integration into teaching and the development of innovative learning dynamics.

3 OBJECTIVES

Starting from the concepts previously presented, the objective of this research is on different levels: on the one hand it wants to investigate the relationship between pedagogy, space, and technology and how these elements can dialogue with each other, creating new opportunities in the learning space; on the other hand, how the user's point of view, when interfacing and experiencing these new teaching experiences, is significant and useful in the design process from prototype to realization.

New spaces, new stimuli provided by technology that reflect the affordance concept proposed by Gibson [10] and Norman [11], require visual tests to demonstrate how this mutual relationship between space and technology can be implemented and vice versa, and how the user can be able to become a director and actor of these new dynamics of use. A process that requires tools that facilitate and simplify this complex dynamic, concerning the number of elements, variables, and actors involved.

A first tool identified as a starting point is the identification and creation of use scenarios, intended as "Design Orienting Scenario" (DOS) able to support the generation of a collective and shared vision among a coherent group of actors. Ways to explore a panorama of alternative possibilities and "thinking material" to orient the strategic conversations between actors [13].

If a first phase involves a demonstration to develop and interpret some new needs emerging in the educational environment, the research consists of the development and evaluation of an iterative process of prototyping.

Prototypes understood as a process that, on the one hand, provides an opportunity to test and verify the scenarios assumed, but they can become "Agonistic Spaces", places that are not just collectors of positive factors or consensus of the stakeholders but creators of an arena that reveals dilemmas and makes them more tangible [14].

Pedagogy and technology are both elements in constant evolution, sudden changes occur continuously and the space that has a physical connotation and character is not always flexible in terms of temporality must face these changes providing opportunities to be shaped and adapted to the ever new nascent needs.

4 A CASE STUDY OF THE POLITECNICO DI MILANO

As seen in the previous chapter, start to rethink higher education facilities with a real prototyping experience is fundamental in the Design process. A big challenge has emerged from present and plans of the Politecnico di Milano, defining a general programme with these primary goals for the next three years, to address the new contemporary needs on the topic by developing different prototypes of innovative university classrooms. An in-depth revision of its spaces 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 educational methods.

For these objectives, a research team of the Politecnico di Milano has been appointed to define a series of requirements and needs for the general organization of the innovative teaching and learning spaces. The team has been asked to dissert on spatial needs, potentialities, new habits and uses, and organize all in spatial requirements in guidelines to be applied first to the 4-classrooms prototypes and then finalized and revised for a large-scale dissemination. Four spatial applications to experiment and involve all the users into a participated implementation of the new requirements, that involves all the disciplines of the University (Engineering, Architecture, and Design) transversally. Since a particular application due to specific necessity and differentiation has been considered on the discipline of Design, this paper sets out the whole research program, 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.

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 the design 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 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;
- to embed scientific developments and research results into university education.

5 METHODOLOGY

Learning is no longer bound by classrooms, learning happens everywhere [15]. Rethinking educational spaces means being in tune with the new needs, trends and other factors that underlie the ways of living the university environment. The objective of the 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 the stakeholders face living these spaces.

Following this objective, the research team of the Politecnico di Milano has been called to draw up guidelines for the definition of classrooms for innovative teaching. Since it has been decided to adopt a user-centered method, categories of research participants have been defined to involve them in the research process. It is possible to divide them into four categories such as 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

Different actions have been realized. The first step was to analyse the different types of teaching carried out in schools to identify macro-areas of intervention on space and the various learning behaviours implemented in various disciplines. The second step was to meet the Politecnico's centres that are dealing with the didactic interaction formulated through the use of technologies (the METID centre which has designed a room to test the use of technology in innovative teaching and the EDME laboratory that offers a physical space in which to develop and undergo experiences of digital, multimedia and multi-sensory worlds.

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

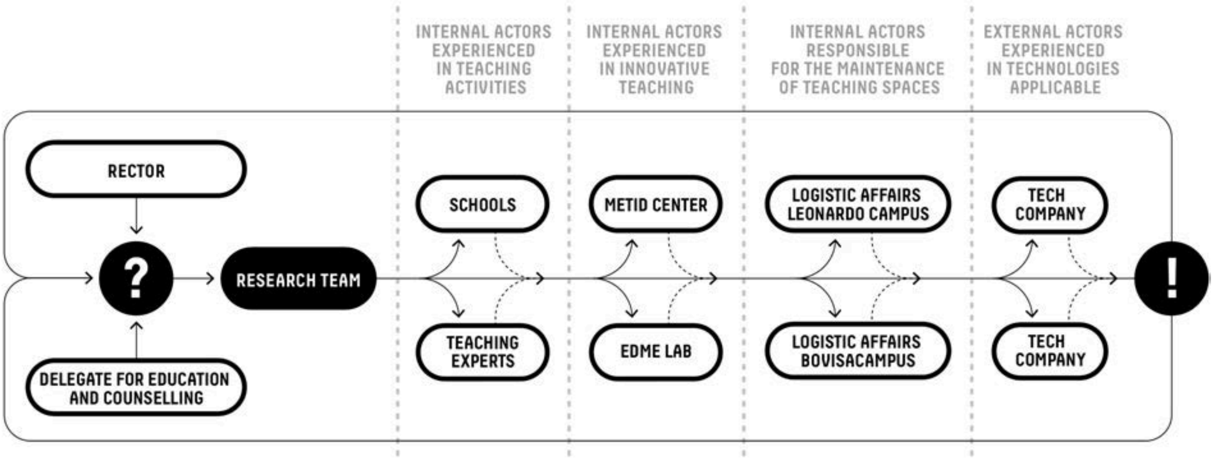

Figure 2. Map of the actors involved in the research process.

6 GUIDELINES

To simplify and organize all the elements considered fundamental in the design of spaces as a support for new educational experiences described in the previous chapters, some guidelines have been outlined. A tool to foster a dialogue between users involved in the research process and easily readable and malleable in all the project phases, from the realization of the scenarios to the test up to the real use of these spaces.

The guidelines mentioned above are organized in four different parts, as reference process steps:

- presentation of the transversal parameters and objectives identified for the reading of the design choices;
- identification of varying levels of intervention and catalog of elements organized in a hierarchical way to respect the designated levels;
- relationship and dialogue of the proposed media through diagrams that favor the choice of the components according to the chosen teaching experience;
- exemplification through use scenarios that support the understanding of the changes and possibilities envisaged.

6.1 Parameters

Transversal parameters for reading all the proposed requirements have been identified as necessary rules and criteria that must be respected and which guide the understanding of the elements recommended and prefigured in the following sections:

- 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 clear 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 to the maintenance of the provided equipment.

In addition to these base parameters, after the evaluation of case studies of contemporary campus projects and working spaces, some requirements have been defined on the definition of the layout of the classrooms, useful to foster the improvement of the so-called soft skills. Rules related both to the Infrastructure but essential to guarantee from the one hand, new uses of the spaces involving new interactions between the stakeholders and new relational needs, but also to support the flexibility and quick change of the actions and organization inside the classroom.

All possibilities able with the creation of three main functional areas: didactic area, informal area, storage area with a ratio of 70/15/15, where:

- The didactic area, defined as the portion of space set up to support the academic action (even if of an innovative one), 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 which 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, a container of all the elements not used in the personalization of the function performed.

6.2 Levels of intervention

A section of the guidelines is dedicated to the possible levels of intervention, since the criteria defined are linked both to the container and the content, including a catalog of elements and supports related to hardware and software implementation.

According to the primary purpose of the class, it's fundamental to take into account these variables to start the process of definition of the levels of intervention in a defined space:

- the permanent-long-time intervention, when it's more related to the container, but always with particular attention of the maintenance level;
- flexible and molding intervention, more pertaining to the contents and action to be done in the classrooms.

According to this purpose three levels to collect both of the approaches are:

- base level: present in all the classroom: comfort guaranteed from the point of view of acoustics, visual, accessibility, Wi-Fi connection, environmental, energy and furniture;
- + level: presence of floating floor, advanced energy system (movable plugs), sound-absorbing panels, modular furniture, writable panels, advanced audio and video systems, projection systems, smartboards, cameras, cloud;
- ++ level: specific equipment to satisfy the specific requests coming out form the didactic activities carried out (for instance equipment for online immersive learning or online video talk among students and international teachers).

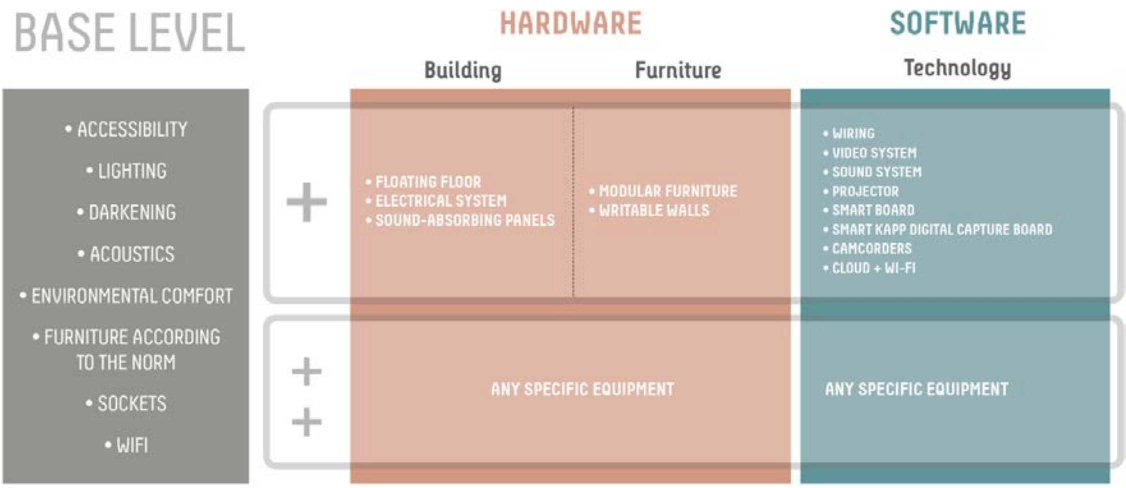

Figure 3. Diagram of the different level of intervention.

6.3 Relationship between the elements

The guideline in this section contain diagrams that favor the choice of the elements according to the chosen teaching experience, putting into effect the educational experience and action to be implemented with the features useful for this result.

In this paper, it's described deeper the realationship bertween the space and the technology analyzing the types of activities and the actors using the space. On the one side, it was important to consider the kind of interaction that takes 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.

The contest was analyzed 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 where the teacher spreads knowledge among the students;
- collaborative didactic activity where the teacher involves the students in the construction of knowledge;
- off-line technology;

- online technology.

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

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

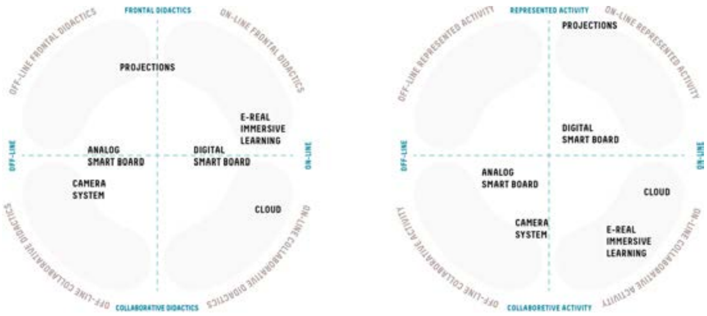

Figure 4. Diagram of the technologies dealing with the space and the people's actions.

6.4 Application in the Design Scenario

To figure out how this diagram can be an useful tool to create new scenarios, here will be presented three possibilities of configuration of the space following the previous steps of the guidelines

(A) Virtual frontal didactic: presents a frontal type mode that allows 360-degree use, using two opposed projected walls that enable you to maintain a position that encourages collaboration in moments of active learning and sharing with colleagues. In this case, the frontal teaching is also virtual and thanks to the installed supports it is possible to attend a lesson held at the same time in a class abroad. It is also possible to see how the informal area outside the classroom favors the use of space for actions and interaction of users not involved in the classroom.

(B) Classroom activities: the furnishings, in this case, are interaction facilitators and allow a quick reconfiguration of the classroom to facilitate teamwork. The support storage area accommodates movable dividers that enable the preparation of tools for group work in free space. The surrounding walls can be used entirely for setting up drawings or sharing support.

(C) Collaboration activities: an area has been designed to allow a total involvement in the work review activity even at a distance. A camera is positioned above the table to illustrate the placed material, while a second camera can show the faces of the people around the table. On the opposite wall, it is possible to see the interlocutors at a distance.

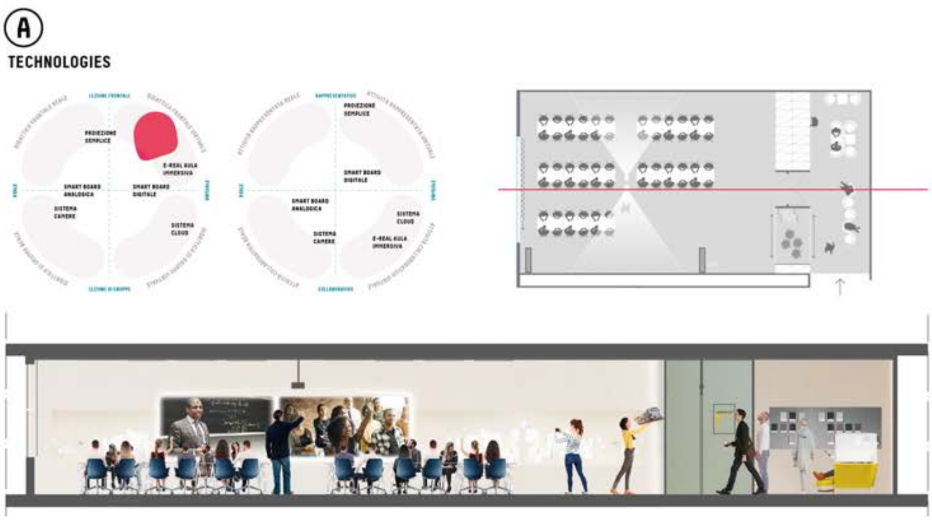

Figure 5. Drawings showing three possibilities of configuration of the space.

7 CONCLUSIONS

A set of human behaviors and relationships, stimulated by the use of technology, can start a rethinking on today's learning systems effectiveness, thus delineating a reflection on the shape and use of spaces. Most of the universities are still harnessed in an old conception of space as a place used only for the univocal distribution of knowledge from teachers to students. Everything concerning the huge baggage of behaviors and activities, active learning's peculiar elements, does not find a satisfactory spatial solution. Furthermore, the emergence of online platforms and training offerings such as OCW, MOOC, and SPOC is revolutionizing the very concept of space and the way in which universities and corporate's training landscape benefit from their own teaching [16]. Today, thanks to digital devices and internet's potentials, it is possible to transform every space of university campus into a learning environment, expanding the very concept of education as an act that can happen anywhere and at any time [17]. In rethinking a new architecture of the physical environment, it is necessary to keep in mind the importance that its virtual space counterpart is acquiring. Furthermore, it seems that a new approach to the use of technology in class design should be encouraged to change the interaction and perception of technology by users.

The experimentation underway at the Politecnico di Milano thus wants to be the first step in verifying the different levels of integration between space and technology, analogical and digital tools, didactics in presence and virtual collaboration analyzing the possible interactions, interpenetration and overlap between different methods and tools for teaching in order to achieve a consolidated and regulated Omnichannel approach.

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