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Educational technologies for hybrid learning contexts: a grid of 12 technological communication tools

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Abstract[1]

The mission of the university goes beyond contributing to society with the results of its research and innovation. Its scope is prompting and supporting young people to gain new knowledge while encouraging them to consider/include forms of social engagement. Then, it is crucial for teachers to engage students in the learning process. Students use technology to communicate; thus, they are more likely and comfortable to participate in a technology-driven environment. This purpose could be pursued through the correct choice of educational technologies within the learning environments. Communication technologies have the potential to engage learners while also providing motivation and support for both teaching and learning. This paper focuses on the definition of educational technologies and on the description of a grid of 12 technologies that were chosen based on the research activities undertaken in doctoral research at the Politecnico di Milano. Subsequently, the technologies are classified through different mappings and methodologies to produce a description showing advantages, disadvantages, and contexts of use. Finally, it analyses the technologies from the point of view of 2 learning contexts, on-site and online, to help create new hybrid learning processes.

Keywords: *Educational technologies, hybrid learning, personal devices, technological classification.*

1. Introduction

Universities and colleges around the world are facing the challenges of rethinking higher education processes and facilities to respond to the emerging needs imposed by the pandemic and the significant sudden changes in the delivery of education. They have been compelled to make significant changes (Barbati, 2020; EUA, 2020; OECD, 2020) as a result of the widespread adoption of digital technologies. ICT, more than ever, plays a central role in our lives, as well as our learning. The proliferation and

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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 understand better, and to expand, the discourse around technology to include a debate on the development of digital learning spaces and hybrid learning processes.

2. Educational technlogy: a definition

The attempt to define what is a technological tool for learning must start with the definition of educational technology.

According to Januszewski & Molenda educational technology is the study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources (Januszewski & Molenda, 2008).

Within the new active approaches, the learner is in control. Therefore, educational technology claims to facilitate learning rather than to cause or control it; that is, it can help create an environment in which learning can more easily occur (Januszewski & Molenda, 2008). “Educational technology refers to the use of tools, technologies, processes, procedures, resources, and strategies to improve learning experiences in a variety of settings, such as formal learning, informal learning, non-formal learning, lifelong learning, learning on demand, workplace learning, and just-in-time learning.

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” (Huang et al., 2019). Educational technologies, therefore, involve learning situations in which a physical device, such as a computer or the internet, creates the instructional experience. Almost all learning at any point requires technology. In this paper, the focus will be on computer-based technology learning since it enables degrees of interactivity, computing capacity,

graphical rendering and retrieval of information that would otherwise be impossible (Mayer, 2010).

Because of the interactive nature of technology and the power of its information-processing capabilities, Jonassen (D. H. Jonassen, 1994) proposes that when students learn with technology, it becomes a cognitive tool. This concept is connected to his previous reflection about computers as "mindtools" (David H. Jonassen et al., 1998) because "students cannot use these tools without thinking deeply about the content that they are learning, and second if they choose to use these tools to help them learn, the tools will facilitate the learning process ... Cognitive tools are computationally based tools that complement and extend the mind".

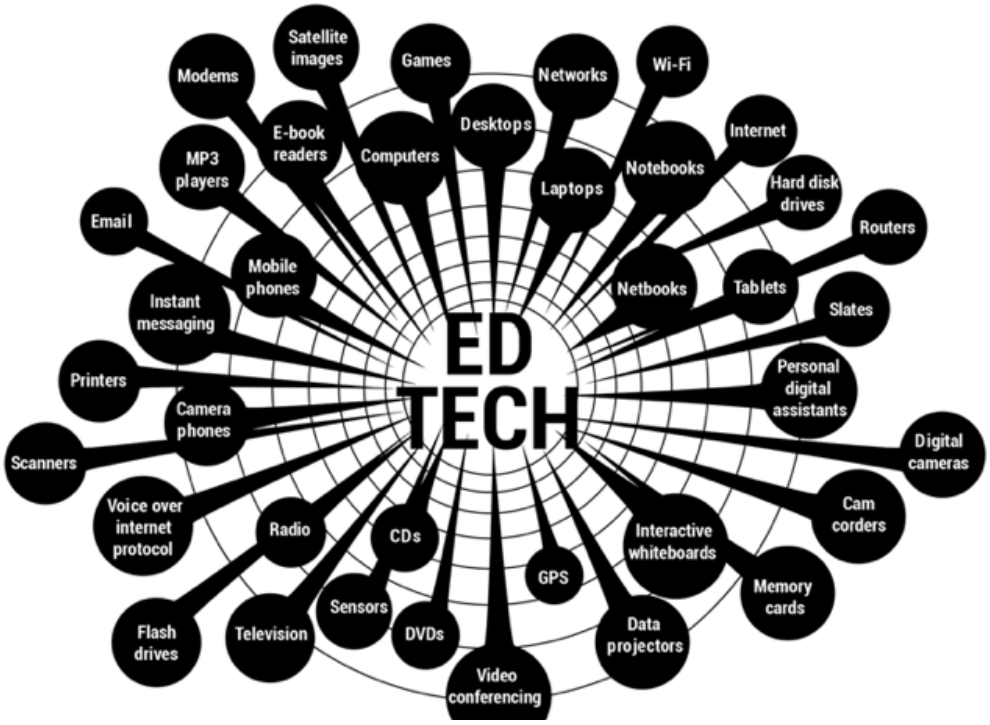

Figure 1: Educational technologies (edited from J. Anderson, 2010).

There are multiple digital technologies, and the reasons for their use are varied. Digital communication technologies, also referred to above as educational technology, include desktop computers; handheld devices such as laptops, smartphones, ultra-mobiles, PDAs and game consoles; digital recording tools such as cameras, voice and video recorders; interactive whiteboards (also known as smartboards); Web 2.0 technologies and other internet sources, such as data and multimedia resources; simulations,

communication and cooperative; storage and cloud; a variety of educational online software packages for assessing, pooling, collaborating, knowledge-creating (Ng, 2015a) and many others.

The reasons given by educational institutions and policymakers for incorporating any or all of these digital educational technologies in learning for students fall broadly into five categories (Ng, 2015; OECD, 2010):

• supporting learning to achieve successful learning outcomes;
• developing 21st-century skills as part of preparing students for the workplace;
• accompanying learners in becoming responsible digital citizens;
• customising learning experience;
• reducing digital divide and empowering digital literacy.

The incorporation of the technology in education, especially the network- and web-based ones, leads to new approaches and new ways of learning. In combination, these modern approaches engage new experimentations with educational technologies.

Digital technologies are claimed in the literature (Cox et al., 2003; UK Department of Education, 2012; Webb, 2005) to promote effective learning creating the conditions for:

• increasing encouragement and promoting cognitive growth for students.
• contextualising learning by offering highly immersive tools that promote real-life experiences and formative feedback to engage students in learning.
• providing tools for making it possible for students to explain what they have learned;
• providing tools of communication and collaboration for interacting with the wider community to gain support during learning;
• providing tools for managing and assessing individuals;
• enabling research by collecting, analysing and displaying data collected in real and virtual experiments;
• enabling access to knowledge on the Internet outside educational institutions through the use of mobile devices, or through learning management systems and other online interactive learning communities' tools.

3. Technologies for hybrid contexts

Computer-based technology has been used for many years in education. Recently computers have pervaded almost every learning environment, at a high cost to educational institutions in terms of resources, time and space. The introduction of the very first personal computers into school classrooms took place in the early 1980s; with the emergence of more user-friendly devices in the mid- to late- 1980s, and for many institutions in the late 1990s with access to the

Internet and the world wide web. To those who have followed the release of these technologies, these dates may seem a little incongruous. It should be remembered that the focus here is on looking into the future of educational information and communication technologies. Education appears to be lagging behind in new technology introduction and deployment (Rickards, 2003). Moreover, when it comes to change related to technology, it is not easy to distinguish between the various aspects of this change. Does it correspond to the implementation of a new device, or a language… an innovation in programming, or a content… a change in processes or instruments? This confusion is notorious in the field of education where many times the means are confused with the practices, the uses with the languages, and the pedagogy (or the way of working) with the techniques. Hence, the same way of naming emerging phenomena can, in some cases, lead to inevitable confusion.

We often talk about "mobile learning" – does this have to do with new mobile communication systems, such as smartphones, or do we also include what was called e-learning? On a different note, when we talk about "collaborative learning" are we always referring to collaboration through technological means? Furthermore, when we talk about "tablets" or "smartphones", should we stop considering "collaborative learning" or "mobile learning"?
The most practical thing is to understand that in the phenomena of educational innovation linked to technology, there is a constant hybridisation between various technical devices, languages, programming, and digital systems that gives rise to new methods and systems. Similarly, it must be acknowledged that when a new method is to be implemented in the educational field, it does so by selecting from among the technologies available those that are most coherent and adaptable to its purposes and intentions. This process of continuous movement of techniques, devices and methods from one technical set to another is what has been recognised as the key to technological innovation by various authors and, in this case, affects the set of technology-based systems within education.

In this paper I propose a grid of 12 technological tools that results from the reviews, observations, experiences and design actions carried out during my doctoral research in the Department of Design of Politecnico di Milano. The selection of the technologies have been made, taking into consideration those used in different contexts, learning environments and experimentations.

Table 1 defines these technologies. 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. Personal and mobile devices have now become sufficiently advanced technologically that they have been called thought-making machines (Houghton, 2013) and the "Swiss Army knife" (Low & O'Connell, 2006) of the twenty-first century with the strength lying in their portability, convenience and pervasiveness (Ng, 2015b). People are moving into continuous processes and practices through technological tools, and users assume that technology can offer smooth, cohesive experiences.

Table 1: Grid of 12 technologies for hybrid contexts

TECHNOLOGICAL TOOL
Digital Smartboard
Analogic Smartboard
Smart Projection
Videoconference System
Smart camera System
Surface Digitaliser
Personal Device
Student Response Software
Collaborative Software
Cloud Software
Virtual Classroom Software
Assessment Software

Subsequently, an attempt was made to position the different technologies within different mapping frameworks to analyse them from different points of view.

3.1 Four Cs Framework

Jacobsen et al. (Jacobsen et al., 2013) have built a perspective on four topics focused on recent studies on the technology used in higher education and learning (Figure 2), recognizing that digital systems and the creation of new tools and processes are continuously advancing. The four categories: connecting, communicating, collaborating, and creating can be used to frame how promising learning technologies are currently used in higher education.

Figure 2: The Four Cs Framework for exploring technology for teaching and learning in higher education (edited from Jacobsen et al., 2013)

The framework can be useful for the initial classification of the technologies according to their degree of influence in on-site and online learning environments according to the dynamics of collaborative and active learning approaches. The identified technologies have been included in the scheme according to the categories of 4C. One technology can find a position in different categories, according to its modes of use.

Table 2: A Technology use in higher education according to Four Cs Framework (edited from Jacobsen et al., 2013)

	On-site ⟷ **Online**				
CONNECTING			Video conference system	Cloud software	Virtual classroom software
COMMU-NICATING	Smart projection Smart camera system	Student response software	Personal device		Virtual classroom software
COLLABO-RATING	Analogic smart board Surface digitaliser	Digital smart board	Personal device	Cloud software	Colla-borative software
CREATING		Digital Smart board	Personal device	Assessment software	Virtual classroom software Colla-borative software

3.2 Technological tool map

When the "tool landscape" diagram created by Wenger et al. (Wenger et al., 2009) was viewed through the perspective given by three dimensions: pedagogy, space and technology (Radcliffe et al., 2009), a diagram was generated to explore the nature of technological tools from pedagogy's (personal vs collaborative), space's (on-site vs online) and technology's (soft tech vs hard tech) point of view. Originally the map used different polarities: participation vs reification, synchronous vs asynchronous, group vs individual. The map is an attempt to convey how a representative set of technologies fit these perspectives in one single diagram. This perspective offers a vocabulary for discussing the role of tools in our users' activities and how those technological tools, in one way or another continue to affect the learning process. The three polarities in the diagram describe different areas:

• the horizontal axis describes physical and digital rhythms by the positioning of hard-tech tools to the right and soft-tech tools to the left. It is a way to think about tool characteristics that appear to build different uses in the learning environment because they require various combinations of materiality and immateriality;

• the vertical axis describes the area of devices' interaction with space, with a gradient between online and on-site. At the top, there are tools that support involvement and knowledge creation in a physical environment, and at the bottom, there are tools that support involvement and knowledge creation in a virtual environment;

• the central and outer circles define the polarity between collaborative and personal learning. The centre circle focuses on the tools that facilitate a cooperative engagement among users within the space. The outer circle focuses on the users, with tools to control participation at a personal level.

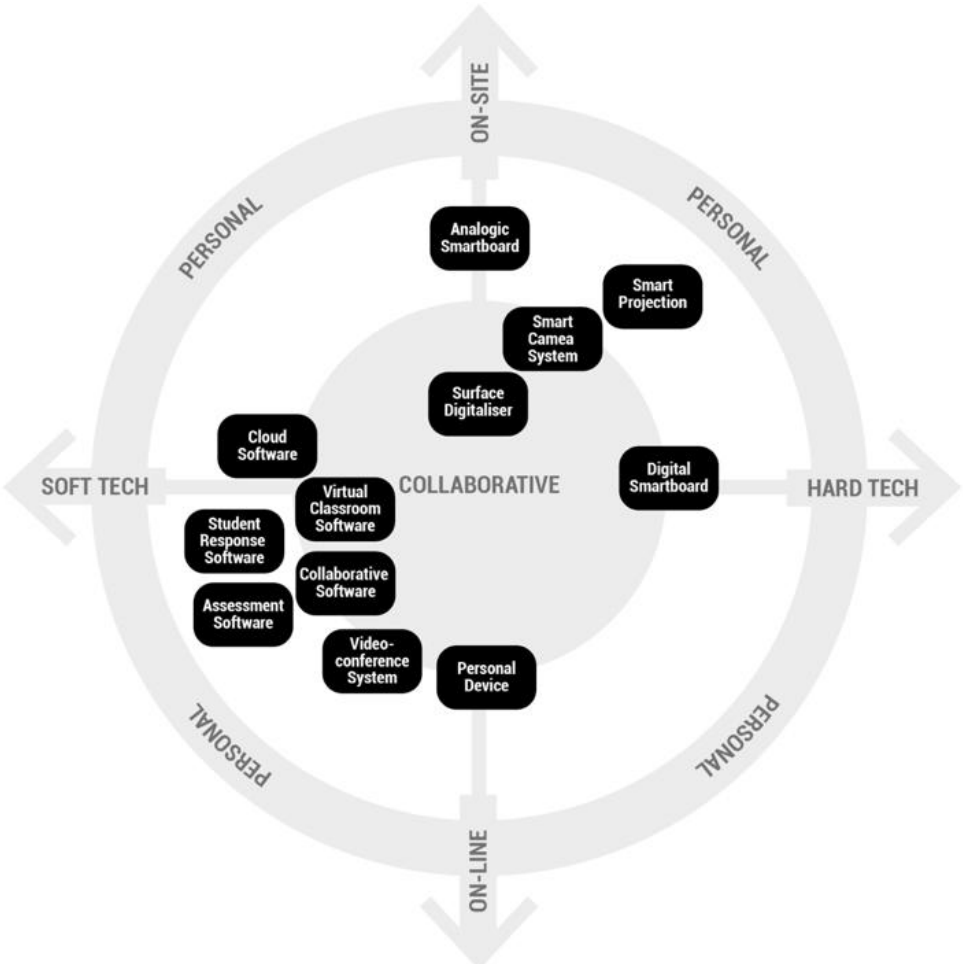

Figure 3: The technological tool map (revised version)

The tools are placed on the diagram in locations that provide insight into the most typical use of a tool concerning the three polarities. The position of a device in the diagram should be viewed both in terms of regions and borders. In other words, the location of a resource in one area is essential, but its location is also important in other regions. For example, virtual classroom software and assessment software are both in the field of soft tech/online interactions, but the first is towards collaborative activities, and the second is more towards personal activity. Technology contributes to the individual-community relationship. While a tool may be built for communities, it is mostly used individually, especially when one is alone. Technology also makes collaborative-personal polarity more complex, which also opens the possibilities for intense multi-membership by offering diverse incentives for cohesiveness. However, technology can help manage those complexities as well.

4. On-site technologies

Theoretically, technology should provide a learning environment that allows excellent and meaningful communication among users. It should be individualised and self-paced. It should allow immediate access to large quantities of data and promote student-student interaction to facilitate peer learning. It should ask questions to test student comprehension and offer expert feedback when errors or misunderstandings are noted (Laurillard, 2002). There is no question that this is a world full of innovations for those who work in the educational sector. Technology surrounds us, and improvements over the last decade in usability and functionality have changed our way of communicating, seeking knowledge, and even doing our shopping. Educational institutions have invested extensively in technology, building computer laboratories, installing electronic whiteboards in classrooms, and maintaining behind-the-scenes learning environments. Any of the technology we use in educational institutions is the same, or at least close to, that which is used more commonly in society, but some are distinct from our academic practices. Furthermore, students add their technologies to the already complicated mix, and just when we think we grasp all the tools and services that we have at our fingertips, it changes again. The experience of the recent months has taught us how indelibly connected technologies are with connections and interchanges between the social and cultural arenas and environments. This should make us even more mindful of the impact of technological tools, and open up new opportunities for enriching and interactive learning environments and experiences.

With this in mind, we should describe on-site technologies that are interested to be implemented in educational contexts. Users need to understand how the interactions between learners and technology evolve fundamentally and how this impacts their educational perceptions and experiences. In the following "cards" a description of on-site technologies is offered, pointing out features such as advantages and disadvantages.

DIGITAL SMARTBOARD	
Description	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
Advantages	Encourages collaboration Reduces formality in communication

	Allows direct interaction with data Usable as small projection Fosters interaction
Disadvantages	Low number of users at the same time Constrained to electric current (not easily movable) Interaction dependent on installed software

ANALOGIC SMARTBOARD	
Description	Large whiteboard connected to the web capable of digitising written content and sharing it on the cloud
Advantages	Encourages collaboration Usable as a normal whiteboard Allows quick sharing of information Reduces the psychological barrier
Disadvantages	Low number of users at the same time Constrained to electric current (not easily movable) Limited interaction

SMART PROJECTION	
Description	Projection that allows wireless connections with mobile devices, home networks, and content.
Advantages	Allows all the users to share information with the class Flexible use
Disadvantages	Sometimes problematic connection Subject to ambient light conditions

VIDEOCONFERENCE SYSTEM	
Description	System between two or more participants at different sites by using computer networks to transmit audio and video data.
Advantages	Encourages on-distance collaboration Allows interaction among different physically distant subjects
Disadvantages	Possible poor quality of transmission depending on the network Interaction limited to a digital environment

SMART CAMERA SYSTEM

Description	System that, following the users, records the activities, publishes the video online and creates recordings for asynchronous learning.
Advantages	Allows blended learning activities Creates repositories of learning contents Flexibility in the chosen content (user or activity) to be recorded
Disadvantages	The set-ups are limited Possible poor quality of the transmission depending on the network

SURFACE DIGITALISER	
Description	Digital systems capable of transforming any wall into a touch surface through sensors and projection systems
Advantages	Encourages collaboration Creates large interactive surfaces Reduces the psychological barrier
Disadvantages	Low number of users at the same time Need for complex hardware systems Limited interaction

5. Between on-site and online technologies

"Educational technologies play an essential role in supporting the seamless integration between formal and informal, physical and virtual learning spaces" (Leander et al., 2010). The prices of portable, personal and technological tools have decreased while rising in functionality, to the extent that their use exceeds that of desktops for most students (Brown, 2005). This is so important that a particular acronym, *Bring Your Own Device* (BYOD), has been coined for this practice (Alberta Education, 2012). In addition to being part of our everyday lives, BYOD 's definition originates in the mass proliferation of mobile apps, which amplifies the complexity of contact between people with electronic platforms and learning environments. All smartphones, laptops, and tablets, owned by users, come from various manufacturers in several types, many of whom seek to differentiate their products from their rival. This fact adds complexity. Furthermore, creating BYOD learning environments is considerably more complex than developing learning for common-technology enriched environments. There are some challenges which include (Walling, 2014):

• customisation or individualisation of the instruction within the limits of the device available to the students;
• location and management of applications or devices for multiple platforms
• use of more detailed instruction or other grouping methods to prevent technical issues, such as the lack of compatible applications for specific kinds of devices;
• management of collaborative activities according to available devices instead of learning habits.
In the following "card" a description of personal device is offered, pointing out features such as advantages and disadvantages.

PERSONAL DEVICE	
Description	Smartphone, tablet or laptop that easily allows connection to the web and interaction with other devices through applications.
Advantages	Easily transportable Ease in sharing information No psychological barrier Increases participation in lectures Multiple applications Supports searching
Disadvantages	High possibility of distraction Too wide a variety of devices

6. Online technologies

Traditionally, interactive communication and connections have been defined and formed mainly through face-to-face learning experiences set up in traditional classroom spaces. They did not include online and virtual spaces or communities. Social networking, communication technologies and learning platforms today allow teachers and students to organise themselves in virtual spaces and shape dynamic connections (Jacobsen et al., 2013).

Online technologies allow students to communicate and interact with online resources and with each other, to build digital artifacts of learning rather than paper-based ones. All these resources provide various ways to cooperate through learning experiences with learning objects and other learners. The added advantage of online learning artifacts being produced and exchanged by students is that their research can be shared with a broader audience, thereby increasing the options for interaction.

The web helps students and faculty to use files and applications over the Internet, and therefore in different locations. This means that personal data can be saved on the web and accessed from any device with Internet access. Accessing the "cloud" means that the individual can use applications online without having to download and install them on the hard drive of their computers, increasing the user's ability to interact with their resources, making modifications or additions as they feel the need.

Web-based applications allow for the omnipresent on-demand access to a pool of online tools. Students can upload materials such as homework, assignments, project work, and other learning resources onto the cloud and later access them from their laptops or mobile devices, in the classroom or at home. In situated learning contexts, they can collect pieces of information and upload them to their cloud space for later retrieval.

In the following “cards” a description of online technologies is offered, pointing out features such as advantages and disadvantages.

STUDENT RESPONSE SOFTWARE	
Description	Online software that allows teachers to create simple quizzes that students can access quickly on laptops or their own smartphones.
Advantages	Provides instantaneous feedback Easy to use and access Checks the live progress of the classroom Engages students in prompt activities Possible anonymous answers to avoid embarrassment
Disadvantages	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
COLLABORATIVE SOFTWARE	
Description	Online software that allows collaboration through tools such as maps or workflows.
Advantages	Encourages collaboration Enables easy creation of workgroups Easy translation of design processes Provides a channel for communications Supports organisation Fosters decision-making

Disadvantages	Interaction limited to a digital environment Not suitable for large number of participants

CLOUD SOFTWARE	
Description	Online software that allows the storing, sharing of files and their easy use on multiple devices
Advantages	Easy to use and access Sometimes limited storage space or limits in file dimensions Limit access to specific folders Support fieldwork
Disadvantages	Possible slow transmission depending on the network Necessity for strict order

VIRTUAL CLASSROOM SOFTWARE	
Description	Online software that allows the creation of virtual environments for delivering courses and carrying out teaching activities.
Advantages	Supports distance education Easy to use and access Adapted for massive courses (MOOC) Accessible with personal devices Develops sense of learning spaces Facilitates feedback Fosters personalised learning
Disadvantages	Limitation in translation of face-to-face learning activities Limitations in learning activities Possible poor quality of the transmission depending on the network

ASSESSMENT SOFTWARE	
Description	Online software that allows the execution of assessments and exams in virtual environments
Advantages	Easy creation of tests Adapted for massive courses (MOOC) Accessible with personal devices Provides transparency
Disadvantages	Need for specific control by the students

	Possible problems in ending the assessment due to the network failure

7. Conclusions

Today, the classroom has extended past four walls into what is known as "virtual space", allowing learning to happen virtually anywhere and anytime (Trentin, 2015). It is possible to think of the 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 amongst the different actors involved in the learning process (Collina et al., 2019).

In hybrid learning contexts, learning co-occurs in a physical space (on-site) and a virtual space (online) to mix and amplify the positive benefits of both contexts since hybrid learning processes happen both in physical and virtual environments (Mariani & Vandi, 2021). Compared to conventional learning environments, the fundamental purpose of technological tools, particularly those connected to the web, is to open new educational possibilities found in these hybrid environments (Tovmassian, 2004). The learning environment can become a hybrid context with various degrees of the presence of technology, oscillating from physical to digital spaces.

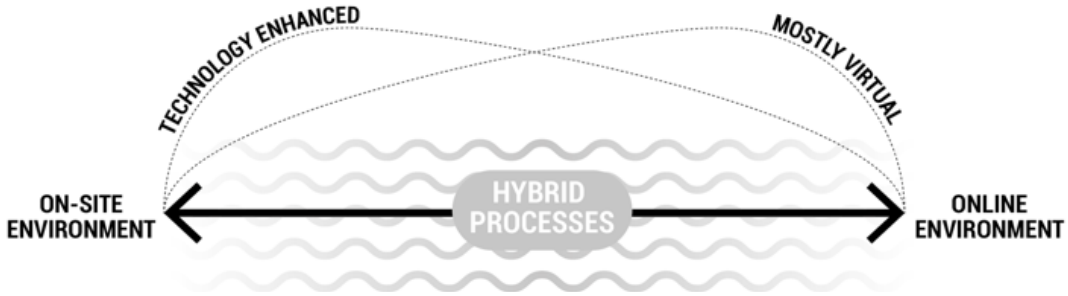

Figure 4: The spectrum of the hybrid learning process (edited from Graham et al., 2013)

Thus, the need for new relationships emerges amongst the technologies present within the physical space and the user-owned personal technologies. "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" (Huang et al., 2019).

Then, a choice should be made about selection and use of technologies in a hybrid learning environment, and questions should be asked. Were those tools of technological communication the right ones? Were they used in the right way? Is there a lack of trust in using tools that have not been used much before? This paper aims to be a tool for making an informed decision in relation to the design of hybrid learning futures in which the learning environment can become a hybrid context, rebounding from physical to digital realms.

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References

Alberta Education. (2012). *Bring Your Own Device: A Guide for Schools*. http://www.k12blueprint.ca/sites/default/files/byod guide revised 2012-09-05.pdf

Anderson, J. (2010). *ICT TRANSFORMING EDUCATION*. https://doi.org/ICT/10/OS/027/1000

Barbati, C. (2020). *Le università "alla prova" della transizione digitale*. Editoriale Scientifica.

Brown, M. (2005). Learning Spaces. In D. G. Oblinger & J. L. Oblinger (Eds.), *Educating the Net Generation* (pp. 12.1-12.22). Educause.

Collina, L., Gerosa, G., Manciaracina, A., Mazzarello, M., & Vergani, F. (2019). University Classroom Prototypes for Innovative Learning. *DRS LEARN DESIGN 2019*, 375–384. https://doi.org/10.21606/learnxdesign.2019.09104

Cox, M., Webb, M., Abbott, C., Blakeley, B., Beauchamp, T., & Rhodes, V. (2003). ICT and pedagogy: A review of the research literature. In *ICT in Schools Research and Evaluation Series* (Vol. 18). http://www.becta.org.uk/page_documents/research/ict_pedagogy_summary.pdf#search=%22ICT and pedagogy. A review of the research literature.%22

EUA. (2020). *Covid-19 and Universities*. https://www.eua.eu/issues/27:covid-19-and-universities-in-europe.html

Graham, C. R., Woodfield, W., & Harrison, J. B. (2013). A framework for institutional adoption and implementation of blended learning in higher education. *The Internet and Higher Education*, *18*, 4–14. https://doi.org/10.1016/j.iheduc.2012.09.003

Houghton, B. (2013). *Mobile Digital Literacy: Analyzing the Walking "Thought Makers."* http://digiacademy.org/EDELCompEduc/Ch1/handheldOS.html

Huang, R., Spector, J. M., & Yang, J. (2019). Introduction to Educational Technology. In *Educational Technology: A Primer for the 21st Century* (pp. 3–31). Springer Singapore. https://doi.org/10.1007/978-981-13-6643-7_1

Jacobsen, M., Brown, B., & Lambert, D. (2013). *Technology-Enhanced Learning Environments in Higher Education : A Review of the Literature*. http://hdl.handle.net/1880/52244

Januszewski, Alan, & Molenda, M. (2008). *Educational Technology* (Al Januszewski & M. Molenda (eds.)). Routledge. https://doi.org/10.4324/9780203054000

Jonassen, D. H. (1994). Technology as cognitive tools: Learners as designers, instructional technology forum. *Itech1*. http://itech1.coe.uga.edu/itforum/paper1/paper1.html.

Jonassen, David H., Carr, C., & Yueh, H.-P. (1998). Computers as mindtools for engaging learners

in critical thinking. *TechTrends*, *43*(2), 24–32. https://doi.org/10.1007/BF02818172
Laurillard, D. (2002). *Rethinking University Teaching*. Routledge.
Leander, K. M., Phillips, N. C., & Taylor, K. H. (2010). The Changing Social Spaces of Learning: Mapping New Mobilities. *Review of Research in Education*, *34*(1), 329–394. https://doi.org/10.3102/0091732X09358129
Low, L., & O'Connell, M. (2006). Learner-Centric Design of Digital Mobile Learning. *Proceedings of the OLT Conference*, 71–82. http://digiacademy.org/EDELCompEduc/Ch1/handheldOS.html
Mariani, I., & Vandi, A. (2021). Designing Interactive Narratives for the Fashion System. MOOC and blended learning in a transdisciplinary design module. *7th International Conference on Higher Education Advances (HEAd'21)*.
Mayer, R. E. (2010). Learning with Technology. In H. Dumont, D. Istance, & F. Benavides (Eds.), *The nature of Learning* (pp. 179–198). OECD.
Ng, W. (2015). *New Digital Technology in Education*. Springer International Publishing. https://doi.org/10.1007/978-3-319-05822-1
OECD. (2010). *Inspired by Technology, Driven by Pedagogy*. OECD. https://doi.org/10.1787/9789264094437-en
OECD. (2020). *Education responses to COVID-19: Embracing digital learning and online collaboration*.
Radcliffe, D., Wilson, H., Powell, D., & Tibbetts, B. (2009). Learning spaces in higher education: positive outcomes by design. In D. Radcliffe, H. Wilson, D. Powell, & B. Tibbetts (Eds.), *Proceedings of the Next Generation Learning Spaces 2008 Colloquium University of Queensland, Brisbane*. The Contributers.
Rickards, T. (2003). TECHNOLOGY-RICH LEARNING ENVIRONMENTS AND THE ROLE OF EFFECTIVE TEACHING. In M. S. Khine & D. Fisher (Eds.), *Technology-Rich Learning Environments A Future Perspective* (pp. 115–132).
Tovmassian, L. T. (2004). *Study on Innovative Learning Environments in School Education*.
Trentin, G. (2015). Orientating Pedagogy Towards Hybrid Spaces. *Progress in Education*, *35*(7). https://www.itd.cnr.it/download/2015 - Orientating Pedagogy Towards HS.pdf
UK Department of Education. (2012). *Using technology to improve teaching and learning in secondary schools* (Issue January).
Walling, D. R. (2014). Designing Learning for Tablet Classrooms: Innovations in Instruction - Using Tablet Technology for Multisensory Learning. In *Springer International Publishing Switzerland 2014*. https://doi.org/10.1007/978-3-319-02420-2_15
Webb, M. E. (2005). Affordances of ICT in science learning: implications for an integrated pedagogy. *International Journal of Science Education*, *27*(6), 705–735. https://doi.org/10.1080/09500690500038520
Wenger, E., White, N., & Smith, J. (2009). *Digital Habitats: stewarding technology for communities*. CPsquare.