

Exploring the drivers for digital transformation in smart education: an ecosystems approach

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Abstract. The adoption of digital technologies in service delivery can modify organizations' and companies' structure, infrastructure and relational patterns by (i) changing the nature of interactions between actors and (ii) reframing human attitude, individuals' intention and users' involvement in value creation. However, the simple adoption of technology cannot ensure the effective digital transformation of companies. Therefore, to address the disruption of contemporary context, especially in service context such as education- that has been dramatically changed by pandemic - users' willingness to use technology and their digital culture should be enhanced to exploit the innovation opportunities involved in the use of technology. Hence, this paper rereads smart education as a service ecosystem to investigate: 1) the impact of technology on actor's interactions and value co-creation, and 2) the different dimensions that can help cities deal with rupture by achieving systems readaptation and transformation. The reinterpretation of smart education as a service ecosystem can allow the identification of the different kinds of technologies and human behaviours (intentions, attitude, citizens' digital competencies and willingness to use technology) that can act as key enablers for the creation of new rules to coordinate exchanges and interactions and for the transformation of crisis into opportunities for innovation.

1 Introduction

The increasing pace of digitalization is posing multiple challenges to economic and social ecosystems. Public and private institutions worldwide are forced to comply with the demands of digital era, which have been further intensified by disrupting events such as global health and political emergencies [1].

Digital transformation is changing and disrupting the norms, rules and practices that guide value creation by reframing actors' roles and connections, their attitude and orientation, the way in which they exchange resources [2]. The application of technologies to business processes can reshape (and at the same time obstruct or improve) people's interactions and enhance their skills by giving birth to the co-development of new solutions that redesign traditional service provision and advance new means to manage old problems.

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The global health emergency requires companies to adapt to the economic, cultural and technological changes that redefined the ways of working, living, interacting, studying for workers, citizens and consumers over the last two years. This disrupting phenomenon emphasized further the need to redefine digitally the strategies for value creation by showing that contemporary private companies, public institutions and organizations should remodel and orientation, the practices for resources exchange and knowledge sharing to address the pandemic.

Even if the effects of the global crisis cannot yet be fully assessed and measured, the use of smart technologies can be considered as one of the key factors for emergency management [3, 4].

Technology plays a key role in the enhancement of resources exchange, especially in services based on the provision of culture such as education, by redesigning the processes of culture sharing, the interactions students-scholars-management, the evaluation process for students and scholars.

After the advent of pandemic, education system had to adapt quickly to the changing scenario by applying distance learning tools. The redefinition of the traditional ways to provide learning services and the introduction new techniques imply the readjustment to a new reality where distance learning can become a new practice and can bring new rules for the entire learning community that will become commonly accepted institutions in the future.

Education is based on negotiation, agreement and mediation as key drivers for the exchange of value, knowledge and culture. For this reason, this system can be intended as a service ecosystem in which the complex sharing of (implicit and codified) knowledge in the community aims at satisfying shared goals through the acquisition of skills, culture, meanings, shared language for all the actors involved.

The service ecosystems approach [5, 6, 7], employed in extant research to observe how digital platforms enable the transformation of businesses [8], can contribute to analyse how to challenge social and economic crisis [9] by providing a systems understanding of how value co-creation process can benefit from disruption by giving birth to new resource integration practices that influence systems' overall well-being during a global emergency. Moreover, the ecosystems view, by providing a multi-layered perspective to analyze the networked system of education, can help shed light on the transformative role of ICT and resources integration [10,11] in the redefinition of the interactions among actors and between actors and technology.

However, despite the increasing diffusion of studies that employ service ecosystems view to analyze systems transformation in times of crisis, there is still the need to identify the key practices that can lead ecosystems to adapt and develop a more resilient attitude to address future disruption [9].

For this reason, to bridge this gap, the study aims at analyzing: 1) how the new technologies for distance learning can modify the key enablers of education ecosystems; 2) how the dynamic readaptation of education ecosystems can lead to the development of transformation and innovation.

Starting from the adoption of service ecosystems view to reread contemporary smart education system, the paper introduces a conceptual framework in which the three contexts of ecosystems (micro, meso and macro) are applied to education context. The framework, then, is used as a conceptual basis for the empirical research that analyses through a content analysis the smart practices implemented by "Digital platform", a platform that offers an integrated set of technologies to transform digitally the education service.

The paper fully exploits the usefulness of service ecosystem perspective in providing key insights on understanding how managerial flexibility, innovation, learning and knowledge sharing can provide companies with the opportunities to pursue growth after a

crisis. The conceptual framework derived from the results can enhance the exploration of the impact of digital technologies on value co-creation (attitude, skills, resource integration, institutions, etc.) to support the emergence of new values that can reframe service modalities and practices to enable the constant transformation of ecosystems.

The article is structured as follows. In section 2, a brief overview on smart education and on the impact of technology on value co-creation in education ecosystems is provided. Moreover, the relevance of service ecosystems' approach as an interpretative lens to examine value co-creation in education is explored. Then, the methodology employed for the empirical research is presented. In paragraph 4, results are reported and discussed to derive a conceptual framework. Lastly, conclusion, implications and limitations are introduced.

2 Theoretical background

2.1 Technology-enhanced learning in education

Over the last decades, education sector has been enriched by new technological systems that can bring advantages to the formative process (learning management system, chatbot, intelligent tutoring system, etc.). Consequently, service providers have been forced to exploit such technological resources to start successfully distance formative paths.

The implementation of an integrated set of technologies can introduce significant changes in actors' behaviour and in their interactions by leading them to co-create new value and to co-develop new social practices, rules and meanings [12].

To redefine the service and provide courses and exams online rapidly, over the last three years smart education has been dramatically redefined through the creation of a complex technological ecosystem based on Cloud computing systems, Artificial Intelligence (AI), Big Data and Internet of Things (IoT).

Potentially digital technologies can increase value and knowledge sharing, by simplifying information and communication flows, strengthening users and providers interactions [13]. Despite the increasing diffusion of studies that analyze the relationship between knowledge sharing and digital technologies [14], in contemporary research and in the period of global crisis, there is the need to explore how value co-creation is actively redefined through digital technologies [15].

The concept of *technology-enhanced learning* [16] has been introduced to observe the implementation of technology-based learning systems through which students can acquire skills or knowledge through the support of teachers or facilitators such as learning support tools and other technological resources [17].

Technology can facilitate more immediate interactions between teachers and students not only during the lessons but also during learning and evaluation processes. Moreover, it can immediately deliver learners' feedback to instructors, help teachers gain real-time perceptions of the students' understanding of the course, facilitate students' cooperative learning [18], and increase students' engagement and motivation. Cooperative learning and peer assessment encourage students to release their evaluation on the work and performance of other students and teachers by creating positive effects on learning effectiveness [19].

However, despite the relevant role of technology in the enhancement of education, there is still a skills gap in the digital skills owned by students [20, 21, 22]. Digital skills are defined by Unesco (2017, p.4) as a "range of different abilities, many of which are not only 'skills' per se, but a combination of behaviours, expertise, know-how, work habits, character traits, dispositions and critical understandings".

On the other hand, the reciprocity in the relationship between teachers and students, one of the key foundations of educational service, is not always guaranteed in the provision of education service. As reported by Bergdhal et al. [22], if teachers do not support students' in using digital technologies for learning, the learners may use these instruments autonomously, which has been shown to be less beneficial and detrimental to learning [23, 24].

For this reason, the great potential in terms of innovation and of enrichment of knowledge offered by the application of technologies to learning and teaching processes must be associated with the sharing of digital culture and skills and with the strengthening of the attitude of the subjects who are forced to use new tools for their daily activities. Hence, the way in which human component should be activated to support the use of digital technologies and remove any resistance to the use of these technologies should be explored [25].

2.2 Education system as a service ecosystem

Education system can be considered as a set of multi-leveled relationships between actors and technology. Hence, the reinterpretation of education as a service ecosystem can help analyze the transformative role of technologies in smart education and in knowledge exchange [11] by observing how Covid-19, and the technological evolution of the era of crisis, reframed the interactions among actors and between actors and technologies [26].

Service ecosystems view [5, 6, 7], employed in extant research to observe how digital platforms enable the transformation of businesses [8], can contribute to analyse how to challenge social and economic crisis [9] by providing a systems understanding of how value co-creation process can benefit from disruption by giving birth to new resource integration practices that influence systems' overall well-being during a global emergency. Service ecosystems view understands service as the glue of resource integration among engaged actors that, through a complex set of technology and ICTs-enabled interactions, can co-create value. The application of service ecosystems view can highlight the value added of systems' capabilities to adapt and pursue continuous improvement to survive environmental changes and can enhance the analysis of a variety of ICT-enhanced smart city solutions to explore human behavior including intentions, attitudes, citizens' digital competencies and willingness to use technology.

Smart technologies impact different kinds of service, from healthcare to tourism and mobility. However, this study focuses on education sector, which is strictly focused on the provision of knowledge and in which the impact of technology seems to introduce new rules for the interactions among actors.

Covid-19 revolutionized the world of education [27], by demonstrating that the resolution of a crisis and the implementation of changes can take place only through collaboration between education providers/institutions and community. The stakeholders engaged in the provision of education service, at public and private level, can combine skills and resources to address social, economic and cultural needs, with the aim of ensuring the continuity of learning, especially for the most disadvantaged students.

The creation of a synergistic system of actors established a virtuous circle of value and knowledge creation and co-creation that also attract talents and young researchers and entrepreneurs, stimulate economic growth [28] and increase the innovation opportunities [29].

Service delivery in higher education can be defined as an experiential kind of learning structured in terms of students' educational experiences in organised community, which are based on interaction activities characterized by the sharing of meanings, languages and an internalized culture aimed at meeting system community goals [30, 31].

The application of service ecosystems view to education sector highlights that the concept of cooperative learning can be matched with knowledge and value co-creation, the cornerstones of the entire ecosystems' architecture. Moreover, the concept of reciprocity in teaching and learning fits well with the win-win logic of mutuality that encourages ecosystems actors to co-create value and multiple benefits for the different co-creators (students, teachers/scholars, top management) engaged.

The reinterpretation of education as a service ecosystem implies the definition of the delivery of education service as a complex process based on learning, teaching and evaluation activities performed through an integrated sets of technologies used by different co-creating actors with different goals and skills connected with multiple relationships based on the exchange of immaterial resources and knowledge across the three contextual levels of service ecosystems [32,33]: 1) micro, 2) meso, 3) macro.

Figure 1 introduces a conceptual framework that applies the three contexts of ecosystems [5, 32, 9] to education system.

The micro-level is composed of individuals' intentions, attitudes, cognitive processes, value perception, skills and resources and can be intended as a subjective sphere in which each actor has her/his cultural background, opinions, beliefs and personal meanings and develops a given attitude toward learning and co-creation and a willingness to engage and share resources and experiences. Moreover, each participant has a different degree of digital knowledge and a different predisposition for the use of technology.

The Meso-level is the intersubjective sphere of relational and social connections between actors in which students, teachers, organizations, institutions integrate resources through interactions that form and reform their mind-set, knowledge personal beliefs and values according to a constant modelling and co-creation of meanings. At this level, actors interact with each other and with technology through human-computer interactions (HCI), the two-way information transfer between human and computer-enabled smart systems [34, 35].

The macro-level refers to the collective sphere of the ecosystem's general community (public administration, institutions, legal system, etc.), in which the new co-created meanings, the new practices for teaching, learning and evaluation are disseminated, accepted and incorporated into the wider educational and social context to become institutionalized practices.

The transition from micro to macro context, that can be defined as an "evolution" from subjective, to intersubjective and collective value creation processes can enable the transformation of the renewed value and knowledge to develop innovation incrementally.

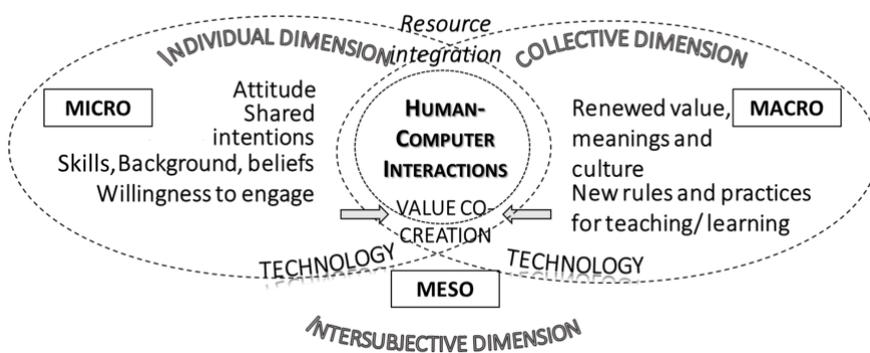


Fig. 1. The enablers of value co-creation in education ecosystems.

Therefore, in the light of the reinterpretation of education system as a service ecosystem (a complex set of technology-enhanced learning systems that reframe actor's interactions, resources integration and value co-creation) the study aims at addressing the following research questions:

RQ1: How can digital tools for learning and teaching influence value co-creation in education ecosystem at micro, meso and macro levels?

RQ2: How can digital tools for education modify the way in which education ecosystems develop value co-creation practices by introducing novelties (new rules, institutions, interaction modalities) in the delivery of education service?

3 Methodology

To address the two research questions, the empirical research analyzes the sector of smart education in Italy by collecting information on the new technological tools and strategies for teaching and learning implemented after Covid-19 pandemic.

3.1 The case: Digital Education

The case analyzed is “Digital Education”, a platform (recognized by the Italian Ministry of Education) for teachers that help perform training, tutoring, orientation, discussion, skills enrichment with the students through digital technologies, according to the perspective of a school based on continuous learning. The Platform aims at simplifying the relationships between teachers and students of primary and secondary school and at improving the frequency of interactions by offering opportunities for learning throughout the school year.

The teachers can use an integrated set of didactic technological tools, contents and pedagogical resources capable of guaranteeing a strong and continuous relationship with students and at supporting the sharing of disciplinary and extra-curricular knowledge.

The digital contributions offered by the platform help to improve the practices of cultural sharing, communication with young people and educational relationships with a high level of security. Through an integrated and diversified set of information and communication technologies (ICT), Digital Education help teachers offer dynamic and engaging extra-curricular lessons, capable of promoting an effective, immediate and customizable learning process, based on the real needs of pupils and students of schools of all levels.

3.2 Data collection and analysis

Data is collected from the official website of “Digital Education” and from the official websites of the different smart projects implemented.

The empirical research adopts an exploratory qualitative approach based on a content analysis as inquiry [36], which allows at extracting from the texts (the unit of analysis) a smaller number of categories and to detect some focal points and key concepts [37] related to the different variables investigated through the application of semantic criteria established by the researchers.

The content analysis detects the main ecosystem's enablers that can help education institutions (intended as ecosystems) that employ Digital Education platform improve value co-creation processes through technological tools (RQ1). Then, starting from the identification of the main enablers of value co-creation in the three ecosystems' contexts, the different kinds of novelties generated (RQ2) in the education ecosystem created by

Digital Education are investigated. The goal is to classify some enabling factors that can support contemporary educational ecosystems (schools and higher education) in the management of crisis, environmental turbulence and technological and market evolutions.

Based on the key enablers of value co-creation in service ecosystems at micro, meso and macro-contexts introduced in the previous paragraph, the content analysis sketch has been designed according to the key variables and sub-variables shown in Table 1.

Table 1. Variables, keywords and content analysis sketch (source: author's elaboration).

Variables	Keywords	Content analysis sketch
RQ1: MICRO-LEVEL		
	Attitude Beliefs Skills Participation Willingness to engage	<ol style="list-style-type: none"> 1) Do the engaged actors own proper digital skills? 2) Do the actors engaged own a smart attitude? 3) Are the actors engaged in a cultural background based on smart technologies? 4) Are the actors favourable to the use of smart technologies? 5) Which are the key technologies based used to improve individual's digital skills and willingness to engage?
RQ1: MESO-LEVEL		
	Interactions Social connections Experience Resource integration Engagement Co-development/Co- design	<ol style="list-style-type: none"> 1) Do the engaged actors interact with each other to exchange resources and knowledge? 2) Are actors involved in the co-design of the offering and/or in the co-development of educational service? 3) Are actors co-creators of other actor's (students/teachers) learning experience? 4) Which are the key technologies employed to simplify the relationship between humans and computers (HCI)? And to improve the delivery of education service (lessons, courses, exams)?
RQ1: MACRO-LEVEL		
	Educational value Smart culture Learning and teaching culture Learning approach Social inclusion	<ol style="list-style-type: none"> 1) Are the values of the entire educational community enriched and renewed after the development of the smart projects? 2) Do the actors re-design their culture and enrich their digital skills through the mutual exchange of knowledge? 3) Are the digital culture of community and the access to technology improved after the development of the smart projects? 4) Which are the key technologies employed to foster the digital culture of the educational community and to introduce new learning practices?
RQ2: NOVELTIES CO-CREATED IN THE ECOSYSTEM		New or improved:
Micro- level	Potential kinds of innovation at an individual level	-Individual skills -Willingness to adopt smart technologies -Attitude toward technology
Meso-level	Potential kinds of innovation at an intersubjective level	-Modalities of actors-to- actors interactions and HCI -Ways to experience learning/ teaching service - Modalities for resources integration
Macro-level	Potential kinds of innovation at a collective level	- Smart culture for technology-enhanced learning - Rules for teaching and learning - Educational mind-set

As for the first research question (RQ1), the main enablers of value co-creation in service ecosystems, introduced in the theoretical background, are employed as macro-variables that can guide THE content analysis. The outcomes of the co-creation are then investigated (RQ2) to detect the new values (interaction/ knowledge sharing modalities, culture etc.) created within the education ecosystem. For the examination of the different types of novelties generated, the sub-dimensions identified in literature, i.e., new attitude for organizations, new interaction modalities, new skills for people, new capabilities are considered as enabling factors for the emergence of innovation [38].

The texts have been explored through complex process of semantic interpretation. The variables investigated have been sub-divided into keywords to facilitate the search for topics and sub-topics within the text, which are then further specified in some sub-dimensions for each variable. The textual units are coded independently by three researchers based on a substruction process [39], which follows a synthesis approach that mediates between deduction (from general variables to specific keywords) and induction (from keywords to further specific sub-dimensions).

4 Findings

The key results derived from the analysis of the textual units collected have been interpreted by researchers in order to classify the key ecosystem's enablers employed in "Digital education" ecosystem to renew the value co-creation practices in teaching and learning process. The findings will be presented according to the key insights arising to address RQ1 (paragraph 4.1) and RQ2 (paragraph 4.2).

4.1 RQ1: ecosystem's enablers for value co-creation

4.1.1 Micro-level: attitude toward technology

At micro-level, the smart education ecosystem employs a set of technological projects aimed at engaging students and at providing them with training activities to use digital tools and with psychological support, through live chat for assistance and for student orientation.

As for the attitude of actors, the project "SPID (Support the participation to digital innovation) aims at improving scholars' understanding of the Internet, to help them navigate safely. The project provides a PEGI guide related to video games in order to get closer to the web in a safe way. In this way, the barriers to the use of technology are removed and misuse behaviors are prevented.

"Digital Security" project, a school initiative promoted by Kaspersky, a leading company in the field of cybersecurity, is developed to involve kindergarten and primary school teachers on network security issues. The project aims at guiding girls and boys in a conscious use of social networks and, in general, of the Internet as a resource.

As for actor's skills, "DigitalMente" aims at ensuring that electronic equipment is used consciously by teachers and students and at the same time intends to transmit the skills necessary to use platforms and technologies in a conscious way. The project dedicates a digital educational kit to teachers and students at secondary schools to explore notions and strategies aimed at "digital well-being". Through the active support of TikTok, the goal of the project is to transmit digital skills and to make teachers and young people aware of the risks that some virtual environments involve and how to avoid them easily, promoting their responsible and moderate use.

As for the shared intention and the willingness to adopt technologies, "Listen to the future" makes available to teachers and their classes agile tools and useful contents which

speak the language of the youngest to generate reflection and critical re-elaboration on an efficient use of technological supports (smartphones, computers) but also on the ability to employ the platforms for distance learning and to navigate the web safely to access the telematic services made available by the public administration, digital payments, treatment of privacy.

Through these projects, the ecosystem launched an integrated set of technologies (based on social networks, platforms, AI and sensors) to engage students, improve their digital attitude and skills, support individual study, provide self-assessment tools (through the automatic drafting of additional exercises and virtual queries).

4.1.2 Meso-level: personalized learning experience

At the meso-level, Digital Education introduces a series of integrated technologies that provide students and teachers in the fulfilment of daily activities (courses, exams, evaluation, etc.) towards the accomplishment of shared goals.

The technologies adopted to improve actors-to-actors and human-computer interactions are experiencing tools, such as platforms and mobile applications for synchronous online teaching and learning in real-time that overcomes any restrictions of time and distance. Moreover, cloud computing systems that support the processes of knowledge acquisition and self-study and the accomplishment of texts are launched. Learning management systems (LMS) based on Artificial intelligence can deploy surveys to categorize individuals into distinct learning buckets (e.g., visual, auditory, text), which can provide effective and targeted content that fits with each preferred learning style.

As for the enrichment of actors' skills, "STEMLab" supports teaching, by providing students with useful ideas for understanding the importance of acquiring technological and digital skills applicable in the scientific and humanistic fields today, to enable them to perform the professions increasingly in demand on the job market.

"Interdisciplinary teaching" is the Project dedicated to kindergarten and primary school teachers, created with the intention of supporting the daily work of teachers, providing interactive, creative and stimulating worksheets, to be used in class or entrusted to children as opportunities to review the topics addressed in the classroom.

"Bianca's laboratories" is based on the concept of learning by doing, allowing teachers and students to observe, but above all experiment, putting their hands to work on phenomena, concepts and events. The Project offers all teachers a new section dedicated to schools of all levels and inspired by these principles. The laboratories make tutorials available to teachers from which to draw inspiration and ideas for lessons, thus obtaining valid teaching support. The proposed tutorials focus on the topics of sustainability, STEM and well-being. The project also provides a series of online activities and experiments that students will be able to carry out in interactive environments to complement their knowledge and to lay the foundations for deeper knowledge.

These projects are based on IRS-based tools that can enable value co-creation among students and between students and teachers. For instance, "Kahoot!AS" and "Menti" are used to collect students' ideas during the activities and the classes. Moreover, student's feedbacks are collected through "raising hand" activities which permits not only to gather suggestions or complaints but allows to store them and to re-elaborate them to improve the service.

Lastly, augmented reality provides the possibility of creating innovative, inclusive and engaging educational environments, capable of encouraging interaction with and between students, by combining training needs and technological innovation.

4.1.3 Macro-level: digital culture and assessment of knowledge

At macro- level, a series of civics projects aimed at creating digital culture and at raising the interest towards sustainability is implemented.

Digital technologies are employed to share in the ecosystem a new digital culture for learning and teaching that can also permit to attain sustainable goals.

For instance, “Sustainable Stories” is a project of civic education which aims at bringing girls and boys closer to the key principles of the circular economy, through an awareness process oriented towards the development of shared responsibility, based on the importance of translating them in their daily habits, making themselves the spokesperson for the urgency of an ethical change. In this project, dissemination acquires a key role: classes will be able to test the acquired knowledge and share it creatively through the narrative tool of podcasts.

Hence, students and teachers are provided with new technologies and tools for evaluation that permit them to self-evaluate their learning and knowledge and to continuously improve not only their skills, but also the education service as a whole. In this way, new teaching, learning and evaluation practices for scholars and students can be developed to catch constantly opportunities for service innovation and continuous improvement.

The tools employed to assess students’ and teachers’ performances allow at administering online surveys on the satisfaction of courses and exams, at tracking users’ behaviour on internet, at collecting data on students and on teachers’ performance.

Moreover, “Circular is cool” is an initiative promoted by “Enel X” for Italian secondary school students. Enel X deals with innovation, digitization and electrification to support a global transition towards sustainability and, in this process, offers teachers and their classes materials to deepen the key concepts of circular economy, financial education and "smart" technology. The path helps co-understand, internalize and share central issues to face the future, such as: sustainable consumption and responsible consumption, ecological footprint, IoT, cashless and much more. The Project also involves students in a national challenge to test acquired knowledge and creativity.

Through the teaching resources and the technologies made available on Digital Education Platform, “Circular is Cool” will allow teachers to involve girls and boys in reflecting on key notions, thanks to which they can stimulate a discussion in the classroom based on statistical data, analogies and metaphors of an increasingly "connected" world, made of the interconnection of culture and on the diversity of the points of view. These tools can help teachers reframe the culture of education, by spreading a new idea of knowledge and culture understood as the result of interdisciplinary skills.

4.2 RQ1: ecosystem’s enablers for value co-creation

The key enabling elements activated in the education ecosystem surrounding “Digital Education” (attitude, willingness to use technology, human-computer interactions, resources integration, creation of a new culture), analyzed to assess RQ1, can give birth to value co-creation, co-learning processes and to the development of new entities at micro, meso and macro-level.

At micro-level, an integrated set of technologies and smart projects are implemented to improve the ability-propensity of students and teachers in the use of technologies based on the enrichment of their digital competencies and on the removal of any resistance in the use of digital tools for teaching and learning.

At meso, level, the use of technologies (LMS, platforms, Artificial intelligence, IRS, augmented reality) can strengthen learning experience and encourage the sharing of

knowledge to obtain new knowledge and give birth to co-learning. The use of these platforms can provide teachers with the possibility to collect real-time perceptions of the students' and increase students' motivation. Cooperative learning, a common concept in education, can be translated into co-learning (co-created learning) according to the principles of service ecosystems view. In this way, new ways of exchanging knowledge and creating new knowledge are generated. Students and digital natives can provide teachers with their experience due to their familiarity with the Internet and with ICTs. Thus, these tools can permit the full realization of the essence of co-learning: education does not imply the unidirectional sharing of knowledge (from teachers to students) but empowers the enrichment of both students and teachers experience, know-how, tacit knowledge, culture and beliefs. By providing their insights and by visualizing other students' suggestions, students can promote a process of co-innovation in which each member can improve the service.

At macro-level, the introduction of new technologies to assess students' knowledge and to perform evaluation practices can develop constantly the opportunities to promote innovation and pursue continuous improvement. The novelties emerged at macro-level can be: 1) new approach to the delivery of education service, that can introduce new practices to be institutionalized over time and to be associated with face-to-face teaching; 2) a new smart culture for training and learning that redefines languages and shared meanings between students and teachers and; 3) a new idea of culture and knowledge, understood as the result interdisciplinary skills; 4) a new civic sense based on the use of digital technologies to attain sustainability. Starting from the collection of students' opinions and from the analysis of their behaviours, teachers can make decisions based on data and adjust teaching according to the information extracted. Data on teachers' and students' performance can be also stored and analyzed through data mining techniques to discover and obtain knowledge from databases, to support the analysis of student learning processes and the evaluation of the effectiveness and usability of online courses.

Hence, it can be noticed that the continuous improvement of the smart educational ecosystems can lead to the re-institutionalization of the new rules and modalities for interactions and service delivery that can lead to the emergence of innovation by allowing organizations at transforming the limitations posed by global crisis into an opportunity for innovation.

5 Discussion

The study explores the key enablers for the redesign of actor's interactions, service provision modalities and technology use in contemporary education system. Through the interpretative lens of service ecosystems view, the context of smart education is reread as a service ecosystem to identify: 1) the main enabling ecosystem's elements to activate value co-creation through the use of new technologies; 2) how these elements can be activated to enable ecosystems re-adaptation to challenge the technological requirements imposed by the crisis and to develop innovation as a result of the complex transformation of the crisis into innovation opportunities.

The key findings of the analysis reveal that the implementation of different tools for different actors with different needs at an individual, intersubjective and collective level (at micro, meso and macro level) permits to personalize the learning experience, by overcoming the challenges of online teaching and learning and fostering the emergence of novelty, unexpected elements, which can act as a source for ecosystems re-adaptation and innovation.

In the ecosystem surrounding the "Digital Education" project, new ways for designing, planning and delivering the educational offering, for interacting with students and for

improving teacher’s and student’s knowledge have been introduced. These novel practices, advanced at first as contingent “tactics”, can become new established practices to be integrated with the old ones. For instance, online teaching can be more immediate and can guarantee more simple interactions with students and colleagues, can help the reduction of costs for travels, increase students’ attention during the lessons and their capability to boost their ability to learn concepts (with the opportunity to listen to the recordings of the lesson).

Therefore, the findings obtained allow at enriching the conceptual framework presented in Figure 1 (employed as a theoretical tool to perform the analysis) and at elaborating a refined conceptual framework, depicted in Figure 2 (derived from the analysis). The framework shows how the integrated use of different tools for smart teaching and learning can help education ecosystem, through a constant re-adaptation of interactions, relational modalities, value, at improving the digital culture of actors and at employing wisely digital technologies to ensure the ecosystems continuity and establish a proactive tension to innovation.

In a process of re-institutionalization [40] the new methods, tools and language for service delivery and the new value and knowledge co-creation practices, introduced as tactics (at meso-level), can be institutionalized at the macro-level and can be transformed in established practices that can “come back” to the micro-level, in which they can become an integral part of the education service offering.

As Figure 2 shows, through the new technologies introduced in the ecosystem, innovation is spread across the three contexts, by enveloping individual attitude and intention (micro-level), learning experience and interaction (meso-level) and overall ecosystem’s culture (macro-level). Therefore, in the education ecosystem a continuous transformative state is established and a proactive attitude that permits to overcome any kind of disruption through continuous improvement and innovation is developed.

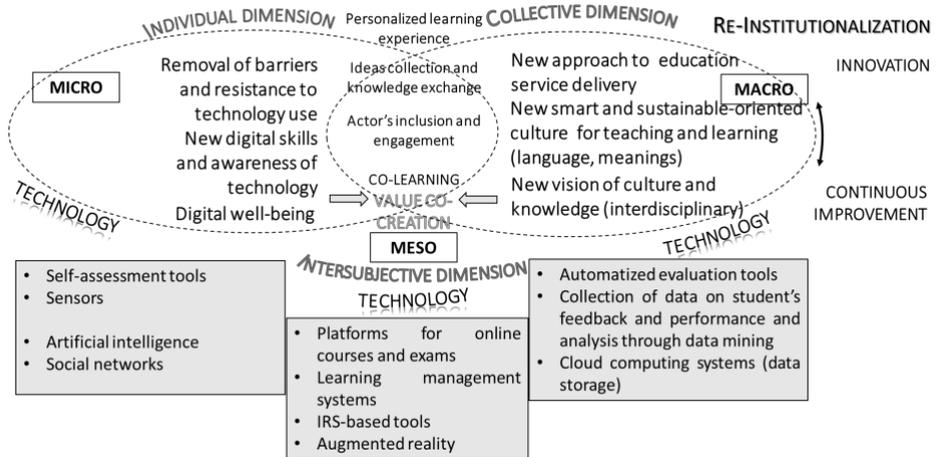


Fig. 2. A conceptual framework for transformation and innovation in education ecosystems.

6 Conclusion and implications

The framework derived from the results of content analysis can help management, practitioners and scholars understand: 1) how technologies for teaching and learning can be employed to comply with the requirements of digital transformation in education ecosystem; 2) how ecosystems transformation and readaptation can lead to the introduction

of new practices for teaching and learning that can change (in the long-term) the interactive and relational modalities of education service.

From a theoretical standpoint, the study classifies the different technological tools that can support the provision of education services in the different moments of service provision and across the different resource integration and knowledge exchange involved in value co-creation and co-learning processes.

The identification of the enablers of transformation and innovation and of the main strategies and tools to reread education service in line with the new demands of digital context can help scholars and practitioners identify the key drivers to overcome social and economic crisis. Moreover, the elaboration of a framework that analyzes how technology can redefine actors' interactions can address a gap in literature related to the absence of studies exploring the role of technologies in reframing social connections within a community [41].

Thus, the framework proposed can help identify how disrupting events can enable the achievement of continuous transformations and changes within ecosystems by developing multiple innovation processes to be regenerated over time [42]. According to a managerial standpoint, education managers can better comprehend: 1) how the use of different kind of technologies can help redefine the interaction modalities between and among students, teachers and community; 2) the key ecosystem's enablers transformation and for the development of different innovation opportunities.

The adoption of ecosystem perspective allows to investigate not only the different technologies, interactive methods, knowledge, skills, orientation to technology but also the way in which these enablers can be combined to develop a proactive attitude that allows the transition from the resolution of the crisis to the emergence of innovation. Thus, ecosystems view permits not only to detect the different types of technologies that can enable innovation but also to grasp the most appropriate strategies for the exchange of resources and for the continuous readaptation of education service delivery to comply with users' needs.

Future research can further validate the conceptual framework herein proposed through qualitative (semi-structured interviews, grounded theory, observation) and quantitative studies (elaboration of measurement items starting from the sub-dimensions identified in the framework). Moreover, the framework can be broadened to include the different barriers to technology adoption and to explore more in-depth the potential inhibitors of value co-creation (technology anxiety, lack of personal interactions, perception of limited digital knowledge) in each context of service ecosystems.

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