Chapter 5. Digital transformation and capabilities

Digital technologies are transforming people's life, business and society. Higher education systems and institutions are particularly affected by digital transformation, which can enable new services and provide new opportunities for innovation and entrepreneurship. Higher education institutions (HEIs) embracing digital technologies can become drivers of growth and development for their own ecosystems. This chapter introduces relevant concepts and definitions on how the digital transformation is affecting HEIs and presents the specificities of the Italian case, discussing good practices and challenges emerged during study visits. Recommendations for policymakers and leaders of HEIs conclude the chapter.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Introduction: Defining digital transformation and capabilities

The rapid development and spread of digital technologies are contributing to change in every aspect of people's lives, business and society. Digital transformation is the result of digitisation and digitalisation of economies and societies (OECD, 2019a).[1] Some authors consider digital transformation as a more pervasive set of changes that digital technologies cause or affecting all aspects of human life (Stolterman and Fors, 2006). The digital transformation is intrinsically connected to what has been defined as the "fourth industrial revolution" (Schwab, 2016): a process through which digital technologies are shaping the future of society and economic development in a comparable manner to the case of steam power for the first industrial revolution.

Digital transformation is a process involving several digital technologies, from 5G to artificial intelligence, big data and Blockchain. These technologies form an ecosystem through which future economic and social changes will arise (OECD, 2019a). In particular, experts identify three categories for seven "vectors of digital transformation" (OECD, 2019d) (Figure 5.1). These properties of the digital transformation differ from the ones related to the past analogic world, with also possible disruptive effects on policymaking. As a consequence, it becomes central for policymakers to take into account these features, and consider the challenges posed by a process, digital transformation, which is a complex phenomenon of different, often uncorrelated, development (OECD, 2019d) (Figure 5.1).

Academics and more generally people working in or with HEIs are becoming increasingly aware of these transformations. For instance, there is a strong positive sentiment about digitalisation from the perspective of scientists and researchers concerning the promotion of collaboration and the efficiency of scientific research (Figure 5.1). However, scientists have more reservations about the role of private sector engagement, the impact that digital technologies may have on the inclusiveness of research opportunities and the engagement with the public. Based on these, the digital transformation and capabilities dimension within the HEInnovate framework could support and enable a better understanding of how digital technologies can be used to support innovation and entrepreneurship in HEIs.

Table 5.1. Vectors of digital transformation

Vector	Description	Examples of policy implications
Scale, scope and speed		
Scale without mass	Core digital products and services, notably software and data, have marginal costs close to zero. Combined with the global reach of the Internet, this allows these products and the firms and platforms that use them to scale very quickly, often with few employees, tangible assets and/or no geographic footprint.	The scale effect of being digital may allow the rapid acquisition of market share – that may also be fleeting – suggesting that policies ensure that barriers to entry and innovation are low, and adjust size-based approaches such as de minimis thresholds and categorisation based on the number of employees.
Panoramic scope	Digitisation facilitates the creation of complex products that combine many functions and features (e.g. the smartphone) and enable extensive versioning, recombination and tailoring of services. Interoperability standards enable the realisation of economies of scope across products, firms and industries.	Policies may need to span multiple policy domains, requiring co-ordination across historically separate issue areas and a more multidisciplinary perspective. This may argue for high-level principles as opposed to narrow rules, a shift from strict harmonisation to interoperability and the convergence of policy oversight authority.

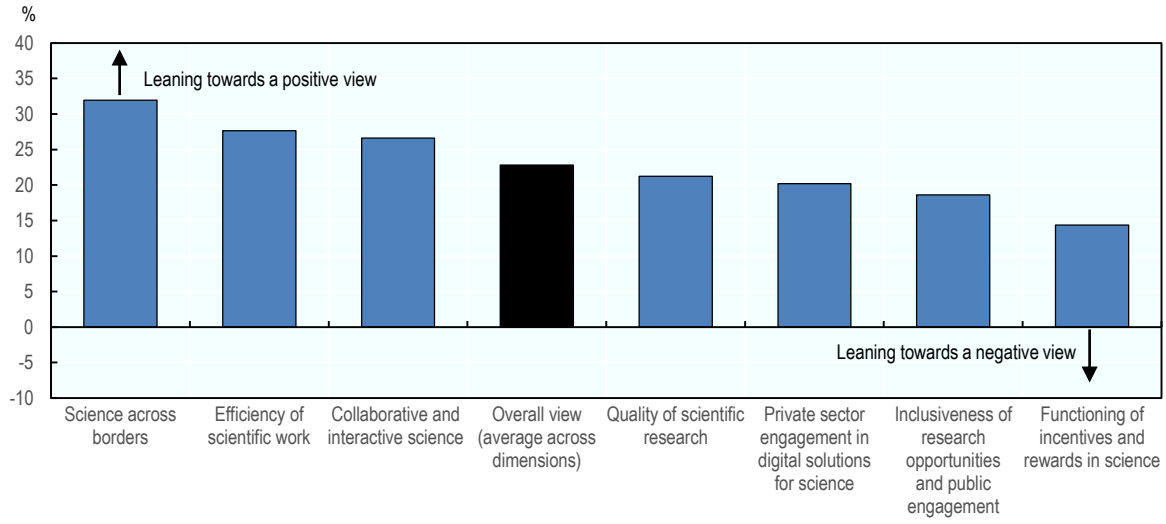
Vector	Description	Examples of policy implications
Speed: dynamics of time	Digitally accelerated activities may outpace deliberative institutional processes, set procedures and behaviours and limited human attention. Technology also allows the present to be easily recorded and the past to be probed, indexed, repurposed, resold and remembered.	Guiding policy principles may be preferred to specific rules that may be quickly rendered obsolete. New approaches such as the use of regulatory sandboxes and the exploitation of data flows and big data analytics may both accelerate and enable more iterative and agile policymaking.
Ownership, assets and economic value		
Intangible capital and the new sources of value creation	Intangible forms of capital like software and data are receiving greater investment. Sensors that generate data allow machinery and equipment (e.g. jet engines, tractors) to be incorporated into new services. Platforms enable firms and individuals to monetise or share their physical capital easily, changing the nature of ownership (e.g. from a good to a service).	Policymakers may want incentives to investment more aligned with the economics of digital innovation and production (e.g. research and development [R&D], data, intellectual property [IP]). The ability to efficiently market services derived from capital equipment (as opposed to direct investments) may have implications for incentives to invest as well as measures of investment and productivity.
Relationships, markets and ecosystems		
Transformation of space	Thanks to their intangible, machine-encoded nature, software, data and computing resources can be stored or exploited anywhere, decoupling value from borders and challenging traditional principles of territoriality, geographically-based communities and sovereignty. This separation creates opportunities for jurisdictional arbitrage.	Policies relying on geographical specifications like nexus, rules of origin or defined markets may need to be revised, to consider other points along the process of value creation and distribution (e.g. location of value creations vs. value delivery). This separation of value creation from use increases the need for policy interoperability between countries and regions.
Empowerment of the edges	The "end-to-end" principle of the Internet has moved the intelligence of the network from the centre to the periphery. Armed with computers and smartphones, users can innovate, design and construct their own networks and communities through mailing lists, hyperlinks and social networks.	Public policies will need to consider reorientation away from the centre (large institutions) and toward more granular units like individuals. This includes policies ranging from digital security and data stewardship to labour and social policies.
Platforms and ecosystems	Lower transaction costs of digital interactions reflect the development not only of direct relationships but also digitally empowered multi-sided platforms, which in turn contribute to further reducing transaction costs in many markets. Several of the largest platforms essentially serve as proprietary ecosystems with varying degrees of integration, interoperability, data sharing and openness.	Public policies need to reflect on the shift of markets toward platforms which may increase efficiencies while re-intermediating and reconcentrating activity that may have implications for maintaining sufficient competition. Governments may need to rethink the provision of public services to take advantage of platforms.

Source: OECD (2019d), "Vectors of digital transformation", https://doi.org/10.1787/5ade2bba-en.

The digital transformation and the HE sector

Digital innovation changes the ways people interact, learn and produce, pushing and driving digital transformation. It creates opportunities for new markets and business models to emerge, together with new products, and directly impacts the efficiency of the public sector (OECD, 2019a).

Figure 5.1. Scientific authors' view on the digitalisation of science and its potential impact, 2018



Source: OECD (2018), *International Survey of Scientific Authors (ISSA) 2018*, Preliminary Results, http://oe.cd/issa (accessed on 15 January 2019).

Digital transformation is affecting and changing significant aspects of education, research, engagement and management activities of HEIs. The education system as a whole is called to adapt and evolve to take advantage of new technologies and tools and to develop strategies and actions to play an active role in the digital transformation process. HEIs can become the driver of digital innovation, including in the provision of the types of skills generally needed to navigate this change of paradigm.

For HEIs, dealing with digital transformation means introducing new digital processes in their organisations, adopting new digital teaching methods and tools, helping students in achieving the skills and competencies needed to act in digitalised societies and economies or having open science policies. It also means adopting a broader view of their role as actors of digital innovation. HEIs, with adequate policies and support from the government, can have an important role in helping firms, in particular small- and medium-sized enterprises (SMEs), adopt emerging technology and acquire relevant digital skills for their workers (OECD, 2019a). Start-ups and spin-offs can benefit from partnerships with HEIs in order to acquire the initial know-how, equipment and funding to test new technologies and scale-up new products and services linked to new the research results in the digital field (OECD, 2019a).

The digital transformation process then becomes an element actively supporting innovation in all HEI missions, including the third mission in all of its dimensions. This implies a dual perspective: the one internal to the organisation with the digital transformation of HEIs themselves, with a new mindset taking into account the challenges and opportunities brought by digitalisation and new digital processes supporting students, staff and researchers; and the one external to the HEI with the enabling role that HEIs must play to foster digital innovation and support a wider ecosystem formed by firms, institutions and stakeholders, jointly pursuing the effort of innovation and growth through the means of new innovative digital technologies.

Digital skills, MOOCs and open science

Digital skills are crucial to navigating today's technology-dense society and economy. However, OECD Survey of Adult Skills (PIAAC) (2012-15) data show that 13% of 16-65 year-olds in many OECD countries lack basic cognitive skills and less than 30% have a cognitive skillset combining high levels of literacy, numeracy and problem-solving skills. Younger generations of workers have a higher level of skills for problem-solving in technology-rich environments, five times more than the older generations of workers. Continuous training and upskilling are necessary to thrive in digital transformation (OECD, 2019b). These figures show the central role of education and higher education as enablers of the digital transformation.

MOOCs stands for "massive open online courses" and represents a new opportunity for digital learning that has developed in recent years. Dedicated Internet platforms provide users with access to MOOCs. Usually, the access is free and students can pay if they want the certificates recognising their enrolment and acquisition of knowledge related to the courses. MOOCs are also used by companies for workers' skills acquisition, with specific training developed ad hoc for these purposes.

"Open science" is a term that refers to the process of making the output of publicly funded research widely accessible to the public (scientific community, business sector and society at large) through the use of digital technologies. Science has an old tradition of openness and, together with the new digital technologies, its actors have created the new paradigm of the scientific enterprise. The main elements of open science are: open access to scientific publications and open data (OECD, 2015).

The emergence of MOOC platforms, of open education and open science, of new digital teaching methods, together with the development of new technological infrastructures, are all developments already changing the practices and the processes in which HEIs accomplish their main missions.

The Italian case

Digital skills in Italy

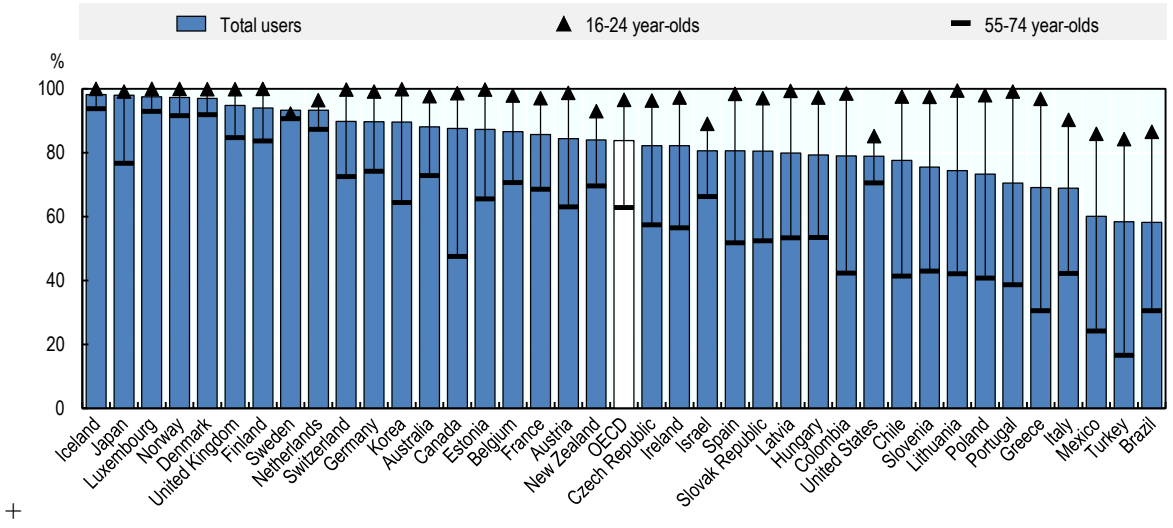
Italy needs to upgrade its skillbase, including digital skills. The OECD Skills Strategy Diagnostic Report of 2017 (OECD, 2017b) recognises how Italy is struggling to make a transition towards a dynamic skills-based society. The mismatch of skills, in particular digital skills, in Italy is an issue that affects the country's innovation capacity (OECD, 2017b). Several indicators show the lower level of digital skills in Italy than in peer countries. For example, Italy ranks very low in the OECD area regarding the use of the Internet, also with respect to the younger cohorts (Figure 5.2).

Moreover, Italy ranks last, within the group of countries for which indicators are available, concerning the percentage of individuals who carried out training, both formal or informal, to improve their digital skills (Figure 5.3).

The Digital Economy and Society Index (DESI) 2019, a composite index published every year by the European Commission measuring the progress of European Union (EU) countries towards a digital economy and society, highlighted the struggles of Italy with digital technology and digital skills. Italy ranks 24th among the 28 members states (Figure 5.4). Among the challenges facing Italy there is still the low level of digital skills. As key actors in the national education system, HEIs have clearly a role to play to help Italy catch up in several dimensions linked to the development of digital skills for students and, to a minor extent, the adult population.

Figure 5.2. Internet users by age, 2016

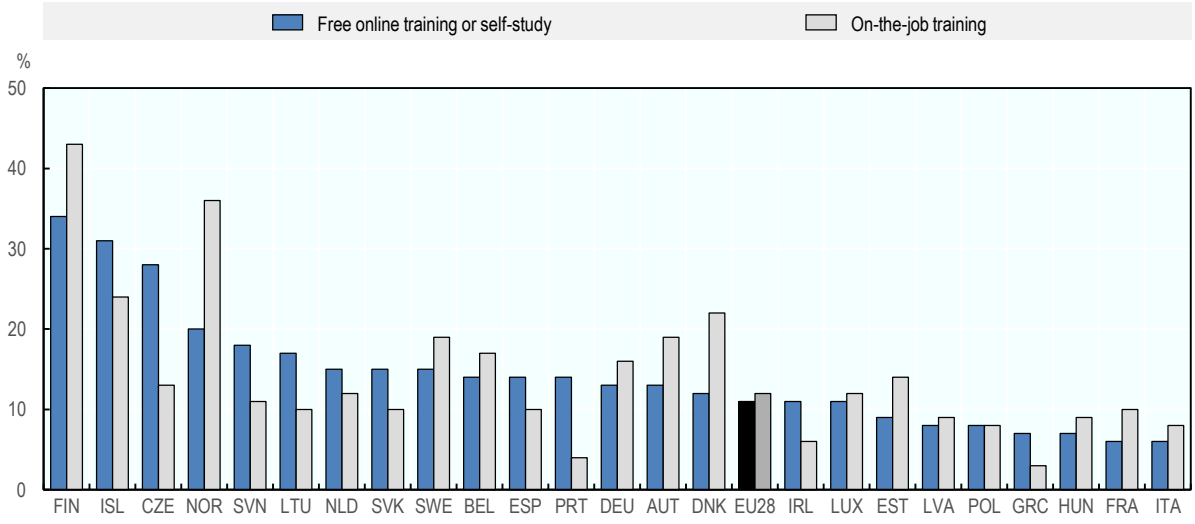
As a percentage of the population in each age group



Source: OECD (2017b), *OECD Skills Strategy Diagnostic Report: Italy 2017*, https://doi.org/10.1787/9789264298644-en.

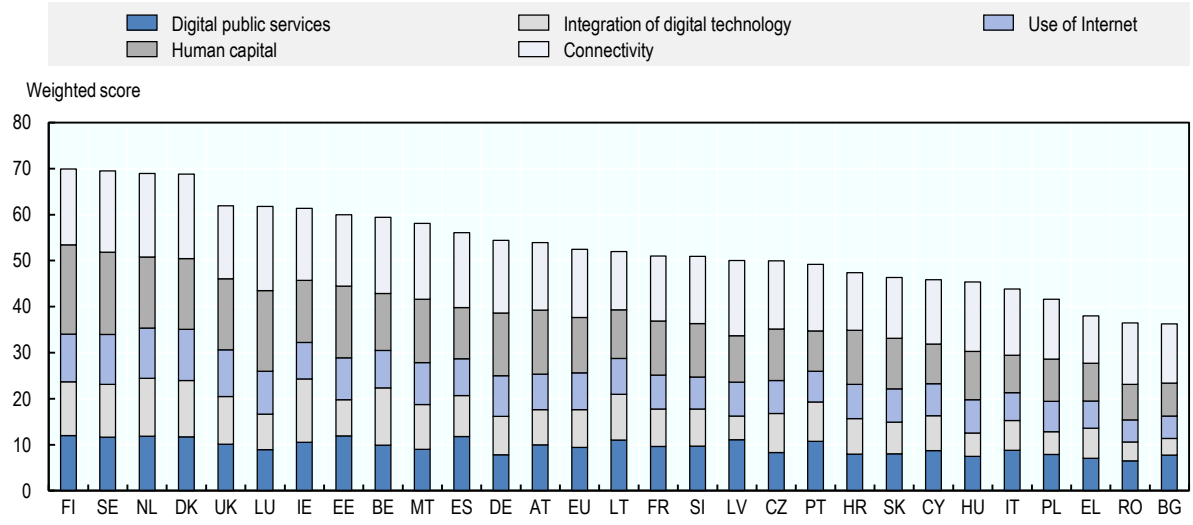
Figure 5.3. Individuals who carried out training to improve their digital skills, by type, 2018

As a percentage of Internet users



Source: OECD (2019b), *Measuring the Digital Transformation: A Roadmap for the Future*, https://doi.org/10.1787/9789264311992-en.

Figure 5.4. Digital Economy and Society Index 2019



Box 5.1. University of Cagliari professional courses for digital skills

Within the framework 2014-20 of the European Social Fund (FSE POR 2014-20), the University of Cagliari launched a course for "Web and mobile application programming and Internet of Things". The course was aimed at acquiring digital skills and promoting employability in the digital economy. The course targeted students with a high school diploma but among the participants, most had a degree in a different subject (from law to philosophy and civil engineering). The course was established in collaboration with 19 local companies lacking digital skills. In total, the course offered 600 hours, 400 hours of internship and the involvement of the university's e-learning training centre. The university also recognised 15-20 ECTS cretids for the course, recognised by the Sardinia Region as a best practice. At the end of the course, 100% of students found employment. The course enrolled a total of 50 students for 200 applicants. The University of Cagliari also works alongside the Regional Digital Innovation Hub to help workers develop new skills, including digital skills.

Main national actors for the digital transformation of Italian HEIs

Apart from HEIs themselves, the main national actors of the Italian HE system playing an active role in digital transformation, together with the Ministry of Education, Universities and Research (MIUR) and the Ministry of Economic Development (MiSE) regarding Industry 4.0 policies, are the following:

- The Agency for Digital Italy (*Agenzia per l'Italia Digitale*, AgID) was created to support the achievement of the Italian digital agenda objectives, to contribute to the diffusion of digital technologies and to support digital innovation. The agency also supports the acquisition of digital skills and overlooks the implementation of the national digitalisation strategy. AgID interacts with several other actors and works in co-ordination with various levels of government (from ministries to local governments), stakeholders, enterprises and experts. To support further the digital

transformation in the public administration, AgID launched a specific task force for artificial intelligence that published a white paper (Task Force sull'Intelligenza Artificiale dell'Agenzia per l'Italia Digitale, 2018) that identified how the public administration and citizens more generally could benefit from new innovative application of artificial intelligence.

- The Conference of Italian University Rectors (CRUI) Manifesto – National Plan for Digital Universities and open science initiatives. The manifesto provides a vision and a strategy to promote digital technology in HEIs. In addition, the CRUI is involved in the promotion of open science, the so-called "Messina open access declaration", issued in 2004, through which Italian universities signed the *Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities*.
- CINECA is a not-for-profit consortium formed by 68 Italian universities, 9 Italian research institutions and MIUR. As of 2018, it hosted the largest Italian computing centre and the Marconi supercomputer, which ranked 19th supercomputer in the world (top500, 2018). CINECA also deals with the development of IT applications and services, providing computing resources, infrastructures and digital services to Italian HEIs. It also supports technology transfer, connecting HEIs with industry and public administration.

Box 5.2. Artificial intelligence at the service of citizens

The Task Force for Artificial Intelligence of AgID produced a detailed white paper, with analysis and recommendations for the Italian public administration in order to obtain the best results from the implementation of artificial intelligence in their services. Among all the other possible applications, artificial intelligence can be used in all sectors of public administration, profitably in the healthcare, education and judiciary systems, public employment, security and, more broadly, in the management of relations with citizens. However, the task force discussed several challenges, from ethics to technology development and the need for more digital skills to be addressed, issues that could prevent to use effectively the artificial intelligence. It provided important elements to help all sectors of Italian public administration use artificial intelligence to empower citizens, in view of artificial intelligence becoming a tool for reducing inequalities and promoting inclusion.

Source: Task Force sull'Intelligenza Artificiale dell'Agenzia per l'Italia Digitale (2018), *Libro Bianco sull'Intelligenza Artificiale al Servizio del Cittadino*, https://ia.italia.it/assets/librobianco.pdf.

National strategies and plans

The Italian government adopted in 2015 the Strategy for Digital Growth 2014-2020 (*Strategia per la crescita digitale 2014-2020*) (Presidenza del Consiglio dei Ministri, 2015). The strategy identified three main overall goals to reach: i) the progressive switch from analogical to digital for the use of public services, using a user-centred approach; ii) supporting growth through the development of digital skills in companies and spreading the diffusion of digital culture among citizens; 3) planning co-ordination and public investments in digital innovation and information and communication technology (ICT) in order to increase the efficiency of the system.

The higher education system is not specifically mentioned in the strategy but the overall goals apply to HEIs too as they are part of the Italian public administration. The strategy implementation follows specific and dedicated actions, from the strategy for ultra wideband to the digital platform for the interaction among public administration, citizens and firms following the "digital first" approach. Moreover, the strategy is connected with other initiatives taken by ministries and the national government, such as the smart specialisation strategy, the Plan for Digital Justice, the National Plan for Digital Schools, and the National Operative Plans on Competitiveness, Governance and Smart Cities.

The National Plan for Digital Schools (*Piano Nazionale Scuola Digitale*), launched with the Buona Scuola reform in 2015, is a plan aiming to stregnthen digital competencies among teachers and students and introduce modern learning environments in schools through digital technologies. EUR 1.1 billion have been allocated for measures such as new infrastructures, technological equipment, training for new digital skills, both for teachers and students. While the National Plan for Digital Schools targets only secondary education institutions, the Rectors' Conference (CRUI) proposed the adoption of a National Plan for Digital Universities (CRUI, 2018) in a manifesto. The plan proposes to develop an overarching strategy to face the challenges and opportunities of new digital technologies. The goal is to reduce the gap between the Italian higher education system and those in other European countries in terms of the number of graduates and performance of the HE system. The proposed plan considers several actions: teaching and learning, competencies, frontier research, knowledge for society, national actions and co-ordinated governance. The CRUI and MIUR opened a bilateral dialogue in order to develop and implement the plan described in the manifesto and to dedicate funding to it.

In addition to national strategies and plans, relevant European programmes also affect the way HEIs use and develop digital technologies for education, research and engagement. In particular, under the current EU Programme for Research and Innovation, Horizon2020 actively promotes open science, open research data and supports the usage of digital technologies in science and research.

Italian good practices

Digital teaching: Massive open online courses (MOOCs)

New services are enabled by digital technologies in education and training. Digital learning can significantly lower the cost of access to training and better meet individual needs (OECD, 2019a). New actors are entering the market of education and at the same time traditional ones, such as universities, can take advantage of digital technologies to develop new teaching and learning material.

One of the most prominent trends connected to the digital transformation of HEIs is the development and growth of MOOCs, which can be seen as the first wave of innovative digital methods for teaching and learning and can attract the attention of digital native students. MOOCs extend the environment in which education takes place and thus foster lifelong learning. MOOCs are also an opportunity for firms that want to invest in human resources development and training, with a lower cost and more flexibility (OECD, 2019a). However, numbers are still low: according to the data available, the share of Internet users who followed an online course in 2016 was below 15% in 30 out of 35 countries with data available (OECD, 2017a).

Internationally, private platforms such as Coursera or HEI institutional platforms such as EdX are among the leading actors in the MOOCs landscape worldwide. Italian HEIs started experimenting the use of digital technologies in teaching and learning well before the CRUI's Manifesto for Digital Universities by offering students study programmes with distance learning and MOOCs. Although the landscape is still very fragmented, many Italian HEIs have shown interest in education through MOOCs. Several platforms have been developed by single universities and also by consortia of universities. Among the visited universities, Federica from University of Napoli Federico II and PoliMi Open Knowledge are worth mentioning as well as the multi-institution platform EduOpen (Box 5.3). A shared feature of these platforms is to be open to other users than their students: future students, postgraduate students, professionals, through post-university and preparatory courses.

Box 5.3. MOOC platforms in Italy

Naples Federico II's Federica web learning platform

The Federica web learning platform, developed by the University of Napoli Federico II, consists of a digital platform and a wide range of digital services and products. Federica Web learning proposes a new model of "content-oriented" services to support learning, combining the academic tradition and innovation of digital technologies. Federica allows for a personalised way of creating knowledge and meeting the needs of the target audience. The platform focuses on three factors: open access, flexibility and portability of contents. Federica hosts 12 courses in English, 2 courses in production and another 25 in programming, together with 48 Italian language courses in the catalogue, with 19 more courses in production and 39 in programming.

Contact: https://www.federica.eu/ - Prof. Mauro Calise mauro.calise@unina.it

Polytechnic of Milan Open Knowledge (POK)

The Polytechnic of Milan is the largest in Italy and has developed its own MOOC platform, POK. The platform is open both to students and users enrolled at the polytechnic but wanting to learn about specific scientific issues. In addition, the platform has also developed specific MOOCs for researchers, teachers and for soft skills ("from university to jobs"). Contents are available both in Italian and English.

Contact: https://www.pok.polimi.it/

EduOpen

EduOpen is an online platform for the design and delivery of MOOCs. It is a consortium formed by 17 Italian public universities. It is a national project funded by MIUR. The platform is free and open, the courses are certified and they give European Credit Transfer Scale (ECTS) credits, open badges and certification. There are 241 MOOCs on offer, organised along 30 paths, with more than 50 000 students enrolled to date. Students can participate in the EduOpen community as translators, transcribers or mentors and, in exchange, receive badges and credits to obtain official certificates for the courses they attended. Enterprises can also decide to use EduOpen to host their courses, which can be co-created with the EduOpen team. Companies can also have a dedicated portal for their courses.

Contact: www.eduopen.org

The CRUI analysed the state of the art in the MOOC market in Italy in 2015, showing exponential growth, from 2 courses in 2012 to 39 in 2014 and 120 in total in 2015 (Paleari et al., 2015). This phenomenon grew spontaneously, with a strong contribution from HEIs already experienced in online teaching and learning. However, HEIs that have not delivered any MOOCs still face organisational issues and, in order to produce and provide online courses, actions are needed to overcome these issues: from specific courses for teachers and professors to investment in technologies and infrastructures.

Moreover, increasing attention has been given by HEIs to the United Nation's sustainable development goals (SDGs) and related initiatives. MOOCs in this area represent an additional channel of engagement of the HEIs with different typologies of MOOC users. It is worth mentioning the "Sustainable Food System: a Mediterranean Perspective" online course developed by the University of Siena, which discusses the challenges and opportunities of the agricultural sector in the Mediterranean area. The course focuses on global-to-local trends related to the achievement of SDGs, outlines the history and culture of agriculture, focusing on the "Mediterranean diet", and explains agricultural data on rural development models and value creation.

To achieve good results in terms of quality of produced contents, quality of teaching, experience for students and users, the creation and distribution of MOOCs must be considered together with the professional training of professors, technicians and staff members in order to maximise the potential of the new tools. Through the Digital Science and Education for Teaching Innovative Assessment (DISCENTIA) project, the University of Cagliari is looking to go in this direction. DISCENTIA is a project funded by MIUR with EUR 1.2 million and is specifically designed to increase the number of teachers with adequate training in digital education. From 35 people at the beginning, DISCENTIA has ultimately trained 600 people, from tenured professors to doctoral students and technical staff. The model of DISCENTIA will become mandatory for new professors and researchers at UniCa.

Open badges and competencies recognition through digital technologies

Often connected to MOOCs, open badges offer digital solutions for recognising competencies and skills acquired both in classic courses and training, but also within MOOC digital platforms. Open badges are digital tools that keep a record of competencies acquired during a course. They are defined by an open standard, which contains metadata that provide information about the organisation, the person to whom they are assigned and the evidence of the positive assessment of the criteria provided by the badge. They provide for a digital credentialing tool that attests education and professional growth, which can be displayed immediately by students. The open badge standard should automatically link the student information system of the universities to the open badge platform, in order to integrate the badges with the university's formal recognition of competencies (e.g. diplomas, ECTS). Open badges can simplify the procedure of acknowledging competencies acquired and defined via external third parties (e.g. in the case of stages, internships, training courses).

Some universities in Italy are experimenting with blockchain technology for the accreditation of open badges. For example, in 2018, the University of Rome Tor Vergata and the University of Cagliari started pilot projects to register student diplomas by using blockchain technology to guarantee authenticity and certify skills (Box 5.4).

Box 5.4. Italian universities' blockchain experimentation

A degree certificate, both in paper and digital formats, is easily falsifiable or alterable. Thanks to technology, it is possible to guarantee the authenticity and integrity of digital certificates for the benefit of potential employers and institutions all over the world. The innovative system allows the issue of certified digital documents, thereby ensuring that they are not falsifiable. The University of Cagliari and the University of Roma TorVergata are both experimenting with the use of blockchain technology in relation to the certification of digital diplomas. The University of Cagliari uses the Ethereum blockchain, while the University of Roma TorVergata uses Bitcoin blockchain technology. Started as two pilot projects, both universities want to progressively extend the service to all degree programmes.

Another interesting initiative is Bestr (www.bestr.it.), the first Italian digital platform for open badges to enhance lifelong learning, an initiative launched in 2015. In 2018, the CRUI identified open badges and Bestr as national references for the representation and certification of competencies. In 2018, to develop the full potential of open badges, CINECA and the HEIs participating in Bestr decided to focus on six core phases of students' university life cycle: guidance; admission and enrolment; exams; credit acquisition and recognition; diploma achievement; and alumni. The platform is used mostly by HEIs for assessing competencies and skills of students, but there are also badges issued by private organisations to assess skills acquired in training courses.

Language skills are the most common badges to be acknowledged, also thanks to the Common European Framework of Reference for Languages (CEFRL) that standardised language skills at the European level. The presence of frameworks and standards, such as CEFRL, help the adoption and spread of open badges as users have a clearer understanding of the meaning of a certain level of knowledge. In Italy, several HEIs are using open badges to assess language competencies, such as the University of Milan-Bicocca, the Free University of Bozen/Bolzano, the University of Padua, the Luigi Bocconi University of Commerce, the University of Trento, the University of Palermo, the University of Turin and the University of Siena, for a total of around 60 badges published and more than 19 000 assignments.

Open badges are also used to recognise the acquisition of soft skills. For example, the University of Trento and the Free University of Bozen/Bolzano adopted open badges to recognise soft skills developed in educational activities related to techniques for active job search and to the work done by students in the university career guidance service.

Open badges can also be used to promote the acquisition of new skills from HEIs internal staff. They can be used to recognise and follow the enhancement and development of the competencies of staff members. For instance, this is the case of the University of Padua, which has promoted the Teaching4Learning@Unipd project to certify the competencies developed by the teachers who take part in the training course for didactic innovation.

Open science

Open science refers to the process of making research results and output more widely accessible in digital format to the scientific community and a wider audience. Digital technologies are the accelerator of this process, which is also embedded in the historical

openness of science (OECD, 2015). Digital technologies allow publishing and distributing the results of scientific research to a wider public, with very low marginal costs. Wider access to scientific results and data can make science more inclusive and help transfer scientific results to society. Importantly, the new open science/open access paradigm implementation must ensure the high-quality scientific publications and opportunities for authors to publish in quality journals (OECD, 2019a).

In Italy, efforts are being made to move toward open access, but open access policies are still to be implemented widely. In 2004, during a Conference in Messina, CRUI promoted the subscription of the *Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities* (2003), which promoted access to knowledge and open access. The Berlin Declaration has to date been signed by 74 Italian universities. In 2013, with Decree No. 91 of 8 August 2013 and with the following Law 112/2013, the Italian government established that the publication of results from research funded publicly for at least 50% should be stored in free-access repositories. However, in 2016, open access publications in Italy was between 13% and 15% of the total Italian publications. CINECA developed IRIS (Institutional Research Information System) as the information system for Italian HEIs to store records of their publications and it has been adopted by almost all universities in Italy.

Policies at the level of individual institutions are currently being developed in some Italian HEIs. Together with national authorities and agencies, individual HEIs have a role to play to encourage researchers and staff towards an open science model (Box 5.5).

Box 5.5. The Liège model of open access

The University of Liège developed a well-recognised and successful model for open access, internationally known as the "Liège model". The University of Liège adopted its mandatory open access policy in May 2007. The policy requires that researchers must self-archive their outputsin the institutional repository of the university, ORBi, following the "Immediate-Deposit and Optional-Access" (IDOA) principle, as soon as the paper is accepted by a scientific editor. ORBi serves also as the primary source for research performance assessment and the evaluation of researchers within the university. In addition, the internal grant distribution process is based on ORBi publication records statistics. During the initial phase of transition, the university organised seminars and classes to train staff and researchers in the use of ORBi. The deployment of ORBi offered the university and researchers an early advantage regarding the dissemination and visibility of scientific results, together with the conservation of publications for multiple purposes.

Source: OECD (2015), "Making Open Science a Reality", *OECD Science, Technology and Industry Policy Papers*, https://doi.org/10.1787/5jrs2f963zs1-en.

The Polytechnic of Milan, where open access has been active since 2014, and the University of Bologna are two of Italy's leading examples. At the Polytechnic of Milan, professors, researchers and collaborators feed the university's institutional open access archive by self-archiving their scientific products in the Re-Public@polimi institutional repository. Furthermore, a working group for open access has been established to define archiving and intellectual property management technical tasks. The University of Bologna, together with its policy on open access and the development of an institutional repository for publications, also invested in the definition of an open data policy; it has been the first Italian university to implement a tool that makes available datasets distributed

under a Creative Commons license via a dedicated university portal (https://dati.unibo.it). While only datasets related to the organisation (e.g. budget, courses, list of degree) are currently accessible, a pilot project on open research data aims to identify projects that can contribute datasets to be made publicly available to the whole scientific community (Box 5.6).

Box 5.6. University of Bologna open data

The University of Bologna is the first university in Italy to implement an online portal that aims to collect, organise and freely provide open data regarding the activities and organisation of the university. The university made the net packages of indexed and navigable data available, distributed under a Creative Commons license, a choice in line with the principles of transparency and participation that are typical of the idea of open government. The first datasets in open data format made available information such as the list of degree programmes, single course details, class schedules, university social budgets and updated facts and figures of the alma mater. In the future, the aim is to open significant scientific datasets from public-funded projects to the entire scientific community.

Contact: https://dati.unibo.it/

HEI third mission and digital transformation

Digital technologies represent an opportunity to foster digital culture as a means for innovation and entrepreneurship. Universities could help actors in their surrounding ecosystems adopt and use digital technologies to become more innovative. Policies and initiatives to support the digital transformation of universities can include third mission activities and knowledge exchange with non-academic institutions. In 1999, the School of Management at the Polytechnic of Milan launched Digital Innovation Observatories. Since then, the polytechnic has established more than 30 observatories, with the contribution of more than 90 researchers and analysts. The Digital Innovation Observatories platform has become a point of reference for a network of more than 150 000 professionals from within and outside academia. The observatories actively disseminate good practices, experience and culture of digital innovation by organising events, publishing papers, press releases and articles.

Many other practices, focusing on digital innovation, have followed the establishment of the observatory. Good practices are scattered across the country, illustrating that digital technologies also provide new development opportunities in HEIs that do not operate in areas where digital technologies are common among local actors. In these cases, HEIs represent drivers of innovation and can avoid a given ecosystem being cut off from the process of digital transformation.

From an internal management point of view, strategic and performance plans of HEIs are putting a lot of emphasis on the use of digital tools. An increasing amount of processes, including student careers, are increasingly becoming fully digital. Data analysis, indicators and databases are at the centre of university activities, as public administration entities. An example of this transformation comes from the University of Siena that started projects to improve internal decision support systems through business analytics and data visualisation tools. For example, the university would like to adopt modern data visualisation and analysis technology for analysing locally the information centrally collected by MIUR,

enhancing this data with others collected locally for better benchmarking and informed strategic decisions.

Box 5.7. Example of good practices in digital capabilities and transformation in Italian HEIs

VidyaSoft – University of Salento spin-off

VidyaSoft is a spin-off from the Department of Innovation Engineering of the University of Salento (Lecce), which was founded in 2015. The spin-off originated from the efforts of four PhD students interested in software architectures, cloud computing and mobile systems, together with the scientific director of graphics and software architecture. The focus of the company was originally about creating a contactless payment system, but later on, the team pivoted toward the creation of an application programming interface (API) platform for fintech called WoX (Web of Topics). In 2016, VidyaSoft won the Sellalab Fintech programme, an international competition supported by Banca Sella. VidyaSoft is then accelerated for 6 months by Banca Sella in the "Internet of Things" sector (IoT), with the aim of achieving integration of smart environments, payment systems and open banking. VidyaSoft acquired a strong knowledge in the development of cross-platform mobile applications, consolidated in a portfolio of projects that embrace risk management, insurance, fintech, tourism, business-to-business (B2B) and eLearning. Today, VidyaSoft has ten employees and the company is located in the Ecotekne campus of the University of Salento. The development of WoX platform is now at the core of its business model.

Contact: www.vidyasoft.it

Another major initiative supporting digital innovation in Italy is the National Plan Industry 4.0 (I4.0). The Ministry for Economic Development (MiSE) launched this plan in 2015. The plan is a step forward toward the diffusion of digital technologies and digital innovation. I4.0 aims to support companies offering assistance in investments, digitisation of production processes, enhancement of labour productivity, training and development of new products and processes. Within the different policies and actions identified by the plan, two are worth mentioning regarding the role of HEIs in the digital innovation ecosystem: digital innovation hubs and competency centres.

Digital innovation hubs are hosted by regional branches of Confindustria, the Italian employers' association, with the aim of enabling networks of local actors (e.g. universities, scientific and technological parks, incubators, local institutions…) in order to improve company awareness of opportunities in the I4.0 area and to support access to funds and investments.

Competency centres are poles of excellence created by universities together with enterprises to raise awareness of I4.0 by providing practical demonstrations of new technologies and best practices. Another important goal of competency centres is to provide services to SMEs in order to strengthen their innovation by offering consulting and services linked to I4.0 opportunities. Universities, in partnerships with companies, provide services and guidance about the opportunities of digital transformation. Eight competency centres, with the involvement of 70 universities and 500 companies, are in the process of being financed with an investment of more than EUR 70 million. Almost all of the visited universities are involved in one of the eight competency centres, some of them (Politecnico

of Milan, Politecnico of Turin, University of Bologna, Scuola Superiore S. Anna, University of Napoli Federico II) project leaders of their competency centres.

Challenges in the Italian HE system

Make digital transformation strategic for the future of HEIs

The Strategy for Digital Growth 2014-20 defined a roadmap toward a digital transformation of Italian public services, and stronger digital skills of citizens and within companies. The national strategy, also pursued thanks to the work of AgID, still lacks a specific component on the role and the actions through which HEIs can participate in the digitalisation of Italy. Some policies, such as in the case of the National Plan Industry 4.0 with the establishment of competency centres, already recognise a central role for universities in relation to the diffusion of new technologies. However, a more integrated and specific strategy for HEIs is needed. Similarly to the National Plan for Digital Schools, the CRUI Manifesto – the National Plan for Digital Universities could become the starting point of a wider strategy for a digital future of Italian universities; efforts will be required to find resources and strengthen co-ordination among all the relevant actors present in the system, from the ministry and the National Agency for the Evaluation of University and Research (ANVUR). The strategy can support actions to reduce the gap between the Italian higher education (HE) system and those in other European countries but also to foster and strengthen the role of HEIs as active players for the digitalisation in the country. It could also promote synergies among the different pillars of the digitalisation of HEIs being:

- the new digital teaching methods, training and development of digital skills
- the use of digital technologies to support the development of research and the contribution of research to investigate the new frontiers and challenges of digitalisation
- the contribution of digital tools in the management of HEIs and support organisational change
- the role that digital technologies can have in the pursuit of HEIs' third mission.

During the study visits, some universities demonstrated having the capacity to kick off processes of digital transformation: many bottom-up initiatives started to arise. A national strategy can help to consolidate and promote successful individual actions developed by the universities to the wider HE system. Some of the bottom-up initiatives at HEI level are part of a broader digital strategy of the university. This is the case for example of the University of Bologna: it has a strategy about the development of its information system as a driver for innovation and organisational change. This process is supported by the presence of a Vice-Rector for Digital Technologies and a single IT organisational unit, lead by a specific manager with the role of "Digital Transition Officer". Universities with a less focused vision and without a clearly defined strategy may struggle to embrace the full potentiality of digital transformation.

The implementation of new digital processes should go together with the creation of a fertile environment that can foster innovation, where HEIs play a crucial enabling role. However, the lack of certainty in national policies such in the case of competency centres is a critical element for the whole system. Also, the Manifesto – National Plan for Digital Universities could be a first step where HEIs, together with MIUR and other relevant actors

at the national level, put the issue of Digital Transformation of Universities at the centre of a national strategy that is now missing.

Invest in digital learning

Investing in the training of staff, technical equipment, technological infrastructure is central if Italian HEIs want to put digital learning as a driver for development and innovation. So, the challenge is twofold: first, training academic staff and helping the developing of new digital competencies, and second, redesigning programmes to include innovative methods and digital tools to help students develop the skills required nowadays. The combination of those two aspects is a challenge for Italian HEIs.

While MOOCs and open badges can improve the capacity of HEIs to engage and attract new stakeholders, one should consider that there are obstacles to overcome for their successful implementation. For instance, completion rates of MOOCs are very low and certification and recognition remains a challenge. Open badges and similar approaches are not yet mature and fully embraced. This is also due to the difficulties in assessing the quality of the large number of courses and material available online. There could be issues regarding the recognition and certification of ECTS for students completing online courses, despite many innovative approaches (OECD, 2016). The CRUI coordinated an agreement among Italian universitis in 2017 to let the students enrol in MOOCs and enable the recognition of ECTSs in a co-ordinated manner, but problems still arise with courses from international institutions or on other platforms not included in the agreement.

The creation of MOOCs requires the capacity to deliver attractive quality contents. New teaching methodologies and communication skills must be acquired by staff and professors. Costs are an important barrier: producing a MOOC is a costly process in terms of hiring profressionals, traning staff and investing equipment and infrastructures. CRUI initial analysis (Paleari et al., 2015) highlighted the lack of a shared methodology for the design and implementation of MOOCs, as no national guidelines existed at the time. To overcome this issue, the CRUI, with its project “MOOCs Italia”, identified national guidelines for the provision of good quality MOOCs for Italian universities.

Spread open science and open access practices

Despite recent regulation (Law 112/2013) stating that at least 50% of the publication of publicly funded research should be stored in free-access repositories, only 13% to 15% of total publications in Italy were open access in 2016. Open science and open access policies have been adopted in the last years by several Italian universities, but they are still a minority: as of December 2017, only 27 out of 97 HEIs had an open access policy. These data show that despite some effort toward the diffusion of open science and open access, these practices are not yet widely adopted by institutions and researchers.

At the national level, several developments have recently taken place. The CRUI Working Group on Open Access, which is part of the CRUI Library Committee is currently working on these issues. The working group supported the definition of guidelines and recommendations for universities. The Italian Association for the Promotion of Open Science (AISA) was established in 2016. AISA is supported by some HEIs. One of the first initiatives of AISA has been a proposal to change the actual copyright law to grant the authors the right to freely make available their work to the public no later than one year after first publication, following what has been implemented in countries such as France and Germany.

A more co-ordinated effort is needed to spread the open science paradigms to the whole HE system. The abovementioned Law 112/2013 is not yet fully applied and the numbers of open access publications are still low. The adoption of research data sharing is even more problematic. Also, the law was originally promoted by the Ministry of Cultural Heritage and Activities for a wide range of other purposes concerning the protection of cultural heritage and just contains a paragraph about open access. The open science paradigm, together with the digitalisation processes, can help the establishment of major co-operation initiatives, through new research infrastructures and the training of researchers. As already mentioned, scientists and researchers already have a strong positive sentiment about the effect of digitalisation on scientific collaboration; this feeling can be a driver for guiding the HE system toward open science.

A more focused national strategy, developed by MIUR in collaboration with the CRUI and other relevant actors could help the promotion and adoption of open access and open science, following, for example, the ATT (Box 5.8) initiative of Finland, where a clear roadmap has been defined, including an evaluation of results. Another interesting example can be found in the Netherlands: to reach the goal of 100% open access by 2024, the National Universities Association negotiated deals with major publishers for open accesse to Dutch publications. European frameworks can help boost open access in Italy: this is, for example, the case of Horizon2020 that has specific clauses regarding the open access policy for access to funding.

Box 5.8. Finland open science and research initiative

The Federation of Finnish Learned Societies co-ordinates the open science activities in all the country, in close collaboration with all actors of the research community. Guidelines and policies for open science are discussed by the Open Science National Strategic Group, formed by representatives of research organisations, libraries and funders. Even if it works with the Ministry of Education and Culture, the strategic group is independent and managed by the research community itself. The Open Science and Research Initiative (ATT) was launched in 2014 by the Ministry of Education and Culture with the goal of creating a national open science and open access policy, and building the proper infrastructure to reach this goal. Beteween 2014 and 2017, open science became more visible to innovation system actors, and transparent, collaborative research has been promoted; together with the necessary skills and knowledge. The impact of the Open Science and Research Initiative was evaluated by external evaluators in 2016 and then by the ministry in 2017.

Source: Open Science (n.d.), *Open Science Coordination in Finland*, https://openscience.fi/en/frontpage; OECD (2015), "Making Open Science a Reality", *OECD Science, Technology and Industry Policy Papers*, https://doi.org/10.1787/5jrs2f963zs1-en.

Digitalisation and third mission: An opportunity not to be missed

As previously discussed, digital technologies are not only changing the way teaching and learning is delivered or research undertaken: they are also offering new opportunities for HEIs to engage with external stakeholders. Digital technologies can be used to establish platforms and networks of HEIs partners and reach out companies of the innovation ecosystem.

When it comes to technology transfer, digital technologies can be deployed to look for financing opportunities: crowdfunding is a possibility that some HEIs in OECD countries are embracing to finance projects in various fields, from research spin-offs to student services. While this practice is already used in many universities, it is still lagging in Italy. An interesting example is offered by the University of Pavia's own crowdsourcing platform Universitiamo. This platform has collected approximately EUR 500 000 in just 3 years, financing about 40 research and third mission projects. Italy has been also the first country in Europe to approve regulation allowing for so-called "equity crowdfunding", which allows donors to receive equity from the financed innovative start-ups. This offers the possibility of collecting funding from a greater range of investors, rather than from institutional and classic investors, an opportunity that could also be used for financing university spin-offs and start-ups.

Italian HEIs, while developing numerous initiatives linked to the digitalisation of different aspects of their activities, rarely integrate third mission in their digitalisation strategy, generally mostly focused on developing infrastructure, offering new digital services to staff and students or creating MOOCs. A reflection on how to integrate these different services with HEI third mission agendas is certainly needed in order to fully integrate digital technologies within the whole organisation and use digital technologies to better support all HEI missions. A more co-ordinated effort at both national and HEI levels can be beneficial in this sense.

There is a need for specialised staff supporting digital transformation. While almost all HEIs already have dedicated staff responsible for third mission activities, less present is the figure of a dedicated person in charge of digital transformation (a notable example already mentioned is the University of Bologna with its dedicated structures and organisation for digital transformation). In addition, full integration between digital and "knowledge exchange and collaboration" is not yet present. People responsible for third mission do not always co-ordinate with those responsible for digital transformation or digital technologies, and vice versa. Integrating these two areas but also more generally with other dimensions and functions, and thinking strategically about digital transformation in all aspects of HEIs, can then make full use of the potential digital technologies have to transform HEIs, making them more innovative and dynamic, ready to be drivers of innovation.

Digital technologies and tools can spur organisational change in HEIs. Fully digitalised processes are drivers of organisational change and make HEIs more innovative. All stakeholders, including students, faculty and administrative staff can take advantage of the availability of data and data analysis. The challenge is to provide good and intelligible data and data analysis. To do so, as previously mentioned, there is a need for specialised and specifically trained staff. helping the implementation of digital processes. Identifying internal champions among different stakeholders can help support the transition to a digital paradigm within HEIs.

Concluding remarks and policy recommendations

As in many OECD countries, HEIs in Italy are using and exploiting the opportunities offered by digital technologies. There is a strong dynamism in terms of actions and initiatives being developed and offered to students and staff. Some HEIs are greatly investing in digital infrastructure, some are leaders in the development of new digital services for students and staff, others are devoting efforts in the development of MOOCs. However other "building blocks" of the digital transformation in HEIs are currently less on

the radar or not immediately linked to digitalisation strategies: these include, for instance, open science and open data or the skills required to maximise the benefits of digital transformation.

National relevant actors, as well as individual HEIs, would need to adopt a broad idea of digitalisation, including, but going beyond, the emphasis on MOOCs and digital infrastructure and services only. This broad conceptualisation needs to take into account that digitalisation affects all HEI missions and activities, from education and skills development to research and engagement. For example, important elements to include in the narrative are, as mentioned above, open science, open data and more generally how digital technologies can support both internationalisation and third mission (collaboration with the business sector, supporting the creation of spin-offs, etc.).

As can be expected, recent developments in the area of digital technologies are unevenly spread across the Italian HE ecosystem, with some universities taking the lead while others are lagging behind.

Given the dynamism and the proliferation of actions and services, it is important for national actors to map and monitor recent developments to understand what works and what does not in an attempt to promote good practices and peer learning, including from international peers.

While mapping the system, it is also important to define overarching strategic goals vis-à-vis the digitalisation of the HEI system. Digitalisation is high on the agenda of Italian policymakers and strategies and actions have already been developed, around the digitalisation of the Italian business sector (*Impresa 4.0*) and public administration for example. Despite being part of the public administration, HEIs are, nevertheless, different types of public actors requiring in some cases more flexibility and ad hoc approaches.

It is therefore important to develop a co-ordinated strategy that takes in to account CRUI proposals and which sets long-term goals around digitalisation. The strategy needs to take into account all the aspects of digitalisation (infrastructure, services for students and staff, MOOCs and education, skills development, open science, open data and the digitalisation of research processes, digital technologies and third mission, etc.) and provide and promote an integrated comprehensive vision.

Notes

[1] "Digitisation", which is the conversion of analogue data and processes into a machine-readable format, represents a first outcome of digital technology. "Digitalisation", represents a second structural step and results from the interconnection of digital technologies, which results in new activities or in profound modifications of existing ones.

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