Education challenges and the technological learning process

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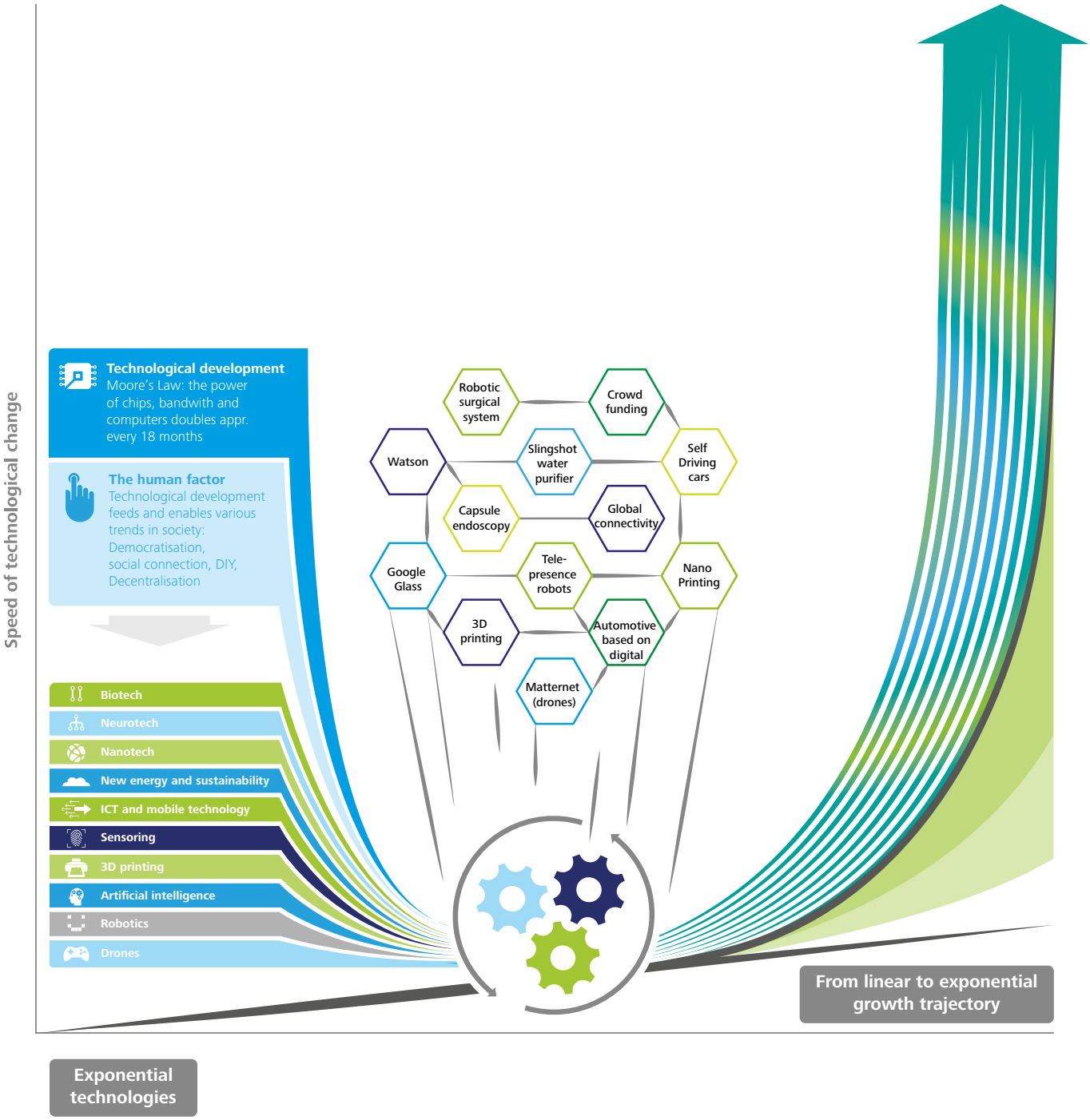
Investment in technology innovation is currently experiencing an exponential rate of cross-industry growth. Its applications for society's routine tasks are growing and branching out to new activities. It is commonly understood that technology has created great value in most of its applications, allowing society to benefit from it.

Figure 1: Technological developments in recent years



The education industry has not been left behind by growth in the use of technology. One of the main signals of this trend is, for instance, the fact that spending on digital education in the US is projected to reach US$26.8 billion in 2018[1], a 100 percent increase from 2014's digital education budget[2], out of which a large amount is expected to be on PC upgrades, tablets, readers, and learning apps.

Elsewhere, starting with its "Opening up Education" initiative in 2013, the European Commission has placed a strong emphasis on the relevance of new technologies in education, fostering investments and projects among Member States[3] in order to reduce the gap between other developed countries.

1 *IBISWorld. Global Mobile Education Market Volume from 2011 to 2020. s.l.: Smart Higher Education, 2013.*
2 *PR Newswire. Education Technology Spend Reaches $13 Billion. Wall Street Journal—MarketWatch. 2014.*
3 *European Commission. Analysis and mapping of innovative teaching and learning for all through new Technologies and Open Educational Resources in Europe. 2013.*

However, due to the sovereign debt crisis and the structure of education financing, which is mostly public (i.e., tuitions fees are generally low or non-existent in the EU, while tuitions fees have grown by 1,120 percent over the past 35 years in the US), the projected growth of technology spending, particularly IT, for education will probably not be in the same league as in the United States.

Despite European Member States' many budgetary constraints, the European Commission—especially through the initiatives set forth in the framework of the Europe 2020 strategy—is making considerable investment in research and project implementation to foster the adoption of technology in education.

The need for technology in education

When discussing public sector activities, specifically in educative fields, the introduction of new technology becomes crucial for its optimal functioning and development.

Education in Europe faces growing challenges, among which:

- Students' job readiness and skill shortages
- Alignment of didactic approaches with new generation behaviors
- Teachers' ability to do more with less due to budget constraints
- Fulfilment of requirement of a lifelong learning experience

As for the first challenge, as proof of the existing mismatch between demand and supply in the job market, in the European Union 90 percent of jobs require at least basic computer skills, whilst 49 percent of EU citizens have low or no computer literacy[4].

Speaking of didactic approaches, if we consider the way humans interact, according to many researchers, the ongoing digital revolution will have a significant effect on the structure of brain and memory similar to the impact of the invention of printing and writing, due to the activation of neurons or cortical areas by activities such as typing on a smartphone or using social media[5].

As already stated, due to the funding structure of education in Europe, budget constraints urge action regarding how budgets are used. In 2011 and 2012, for example, due to the effect of the economic crisis on budget deficits, up to 20 European countries/regions cut their education budgets, with 10 of them experiencing cuts of more than 5 percent. Conversely, 9 countries/regions increased their education budget by between 1 percent and 5 percent, and 4 experienced an increase higher than 5 percent in real terms[6].

The general development of digitalized tools and its implications for the majority of professions means they must be introduced at the earliest stages of the educative process. It is not only the manipulation of modern tools that becomes an important requirement, but transformed and aligned education methodologies and ideologies are also considered crucial. The concept of lifelong learning, introduced in the 30s and defined in 1972 by UNESCO with the "learning to be" concept[7], is becoming even more relevant given the ever-increasing adoption of new technologies and the speed of change.

4 European Parliamentary Research Service. Digital Opportunities for Education in the EU. 2014.

5 L'innovation et le numérique. Serres, Michel. Paris: Université Paris I Panthéon-Sorbonne, 2013.

6 National curriculum in England: design and technolgoy programmes of study. UK Government. s.l.: https://www.gov.uk/government/publications/national-curriculum-in-england-design-and-technology-programmes-of-study, 2013.

7 Faure, Edgar and et al. Learning to be. Paris: UNESCO, 1972.

Technology plays a crucial role in addressing these problems and has been defined as one of the vectors for fostering growth according to the European 2020 strategy.

Technology, combined with a new paradigm of education (i.e., teaching and learning), could solve these issues by making the learning experience more personalized, collaborative, and a blend of formal and informal processes. In the following paragraph, the main trends in how technology is applied to education are listed:

- Gamification and digital badging
- Blended learning and MOOCs (Massive Open Online Courses)
- Project-based learning
- Adaptive learning technologies
- Learning analytics

Technological trends in education

We have selected five trends that are increasingly visible in the technological transformation of education:

1. **Gamification and digital badging**
   The concept of gamification involves the application of game mechanics to specific subjects as an innovation of existing processes in learning or marketing environments. Its scope of application is large and seen as a motivating and incentivizing tool to enhance performance, drive business results, and generate competitive advantage[8].
   The role of gamification already sees multiple fields of application, such as in multicultural education and conflict explanation, food waste and water management, team management, and other sensitive social topics. International organizations and nations develop these kinds of projects and initiatives directly. One example is Green Games, which is an EU-founded project to develop skills and competences in the areas of food, waste water, and energy management in tourism and hospitality.

   Another example is the Jam Today network, an initiative of 25 European Universities, Innovation Centers, Learning Labs, and Business Incubators financed by the EU ICT PSP program. In 48-hour game jams, Jam Today taps into the creative potential of different stakeholders to produce games for learning and resources for teachers on themes like eSkills, Health & Wellbeing, and Mathematics[9].

   Technology has driven the introduction of this innovative concept by seeking improvements in the acquisition of knowledge processes and achievement commitment. In education, this trend takes the form of the use of digital badges, which evidence achievements[10], and the adoption of 3D printing technologies, among others.

   The massive influx of 3D printers in diverse scientific institutions and education represents an interesting case. Learning is shifting to a more practical experience by analyzing and replicating theoretical facts with 3D printing, fostering interest among users.
   Pioneering innovative programs, such as the one installed at the American Museum of Natural History in New York, attempt to create authentic situations to enhance learning experiences[11].

2. **Blended learning and MOOCs**
   Joint learning experiences were first adopted as a cost-saving measure by means of self-learning in web platforms[12]. "Blended learning" and "Massive open online courses" (MOOCs) represent some of the first methodology enhancements that attempt to progress jointly with education.

8 Banham, Russ. The intersection of gamification and big data. Dell Power More. [Online] Dell, 2013. https://powermore.dell.com/business/intersection-gamification-big-data/#.U620aI1dVe4

9 Open Education Europa. eLearning Paper n. 43. 2015

10 Digital Badges in Education. Gibson, David, et al. 410, New York: Springer Science+Business Media, 2013, Vol. 20:403

11 American Museum of Natural History Assigns Students Clever 3D Scanning & Printing Dinosaur Project. 3D print. [Online] September 2014. http://3dprint.com/13383/dinosaur-3d-print-scan/

12 Sharma, Pete. Blended Learning. s.l.: Macmillan, 2007

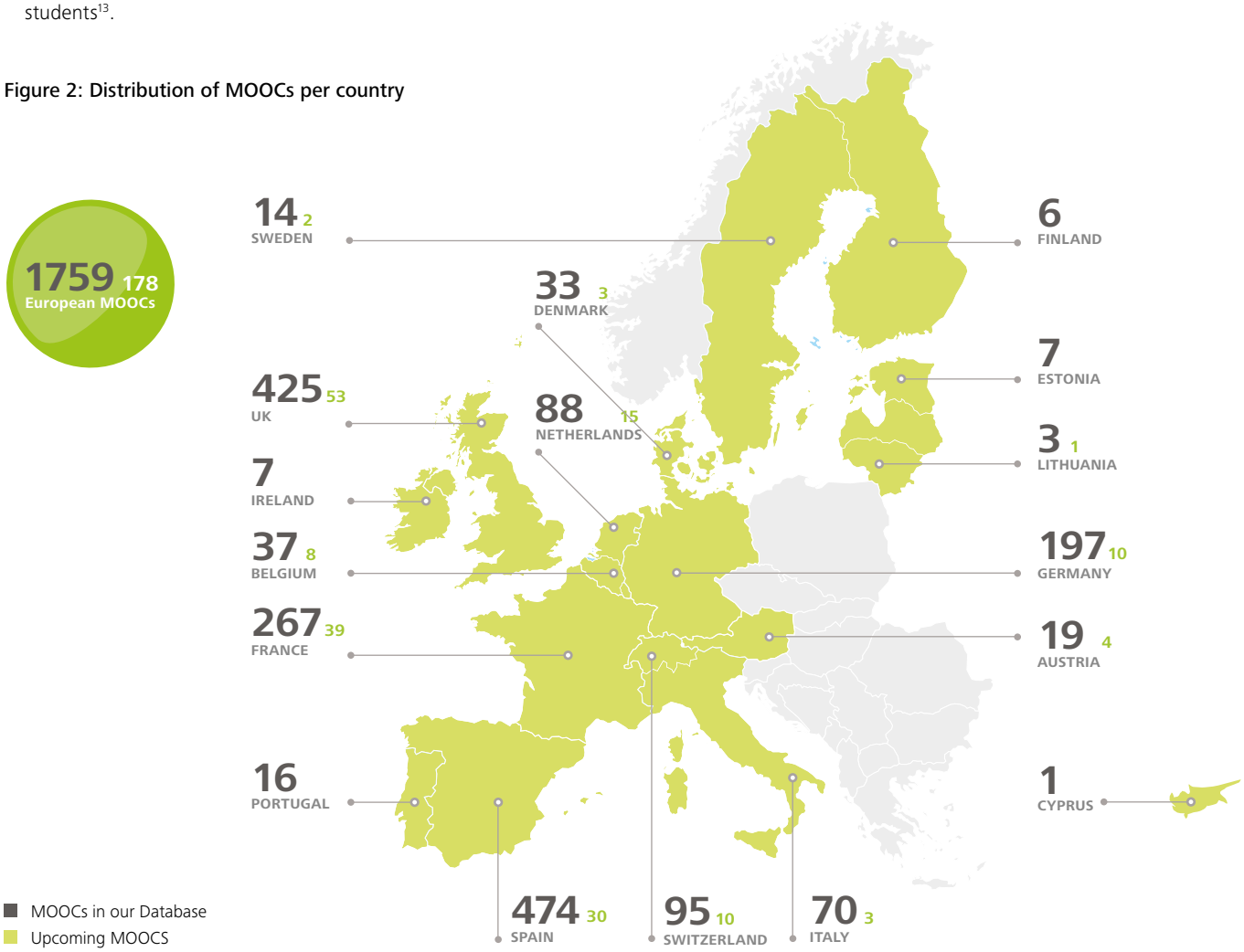
Whereas several education principles and methods have remained unchanged, the impact of technology on the education chain is clear, for example, when looking at the concentration of students via means of technology. Although in most cases, educative enhancements require technology to be updated, blended learning is a direct consequence of technological progress. The progress of shared platforms and live worldwide connections has allowed educative institutions and corporates to promote a new way of knowledge trading and sharing.

According to Coursera Co-Founder Daphne Koller, in 2014, the number of universities offering MOOCs doubled to 400 universities, and the student base with access to them reached more than 18 million students[13].

In Europe, coordinated by Open Education Europa, the number of MOOCs has seen exponential growth, reaching more than 1,700 MOOCs in early August, of which 178 were scheduled before February 2016, as shown in the scoreboard that accounts for courses provided by European institutions, regardless of which platform hosts them.

As expressed in the position papers for European cooperation on MOOCs, the future need is to develop a new system of certification, a unified distribution system, and most of all a sustainable business model to foster the structure of MOOCs across European Institution[14].

Figure 2: Distribution of MOOCs per country



13 *Koller, Daphne. Coursera President Daphne Koller: 2014 Is The Year MOOCs Will Come Of Age. Tech Crunch. [Online] September 2014. http://techcrunch.com/2014/09/10/coursera-president-daphne-koller-2014-is-the-year-moocs-will-come-of-age/*

14 *Jansen, Darco and Teixeira, Antonio. Position papers for European. s.l.: EADTU, 2015*

3. **Project based learning**

"Project based learning" comes as an introduction to the continuous search for authentic real-life situations. This methodology allows students to engage in their learning through experimentation and application of theoretical content in practical situations.

Many investments in higher education, such as the donations made by the Bill & Melinda Gates Foundation[15], are focusing on this specific trend, which is gaining popularity through an increased range of possibilities as a result of digital progress.

Technological progress in several fields, and specifically in scientific subjects, will allow students to receive practical experience within the boundaries of education, increasing specialization and preparedness for future employment.

4. **Adaptive learning technologies**

Adaptive learning technologies refer to software and online platforms that adjust to individual students' needs as they learn. Upon collecting students' behavioral data, adaptive learning technologies often display data visualizations in the form of comprehensive dashboards that can be monitored by teachers.

In this sense, the future is moving towards vocative learning connected to the acquisition of missing skills and core competences in order to meet labor market requirements alongside personal achievements and aspiration.

The European Commission launched a project in this area called Watchme that deploys learning analytics tools to deliver personalized learning.

5. **Learning Analytics and Big Data application**

While the application of Big Data in the corporate world is a commonly discussed topic, the impact that data analytics could have on education is often undervalued. From planning budgets to assessing teachers' and students' performance, data could reshape the structure of learning methods.

Access to global networks and peers with similar paths or experiences could enhance learning methods by establishing cross-country and cross-cultural relations in education thanks to the analysis of performance and results as well as study paths or experience.

Following these goals, the European Commission has already launched some projects[16], including:

- LACE: exploration of plausible future for learning analytics and educational data mining to bring imaginative scenarios to workshops to drive policies and teaching
- PELARS: development of a tool that helps learners and teachers by providing feedback from hands-on, project-based, and experiential learning situations

The five trends described above represent just the main ways through which technology is changing the paradigm of teaching and learning.

Gamification and digital badging, blended learning and MOOCs, project based learning, adaptive learning technologies, and finally learning analytics and Big Data application already have a strong influence on the teaching and learning process despite the low penetration in the European market.

15 Horn, Michael. Gates Foundation Steps Up with Investments in Next-Generation Learning. Forbes. [Online] June 2012

The focal points of a technological learning experience

Technology applied to learning, despite the help that it brings in solving many of the hot issues in teaching methods and the job market, could also raise some points for consideration:

1. **Return on investment and funding**

   Initial investment in technology, especially at its early stages, tends to be expensive considering the breakeven will only be achieved in the long term. Moreover, it is important to consider that breakeven might not be achieved if a disruptive effect does not occur at a certain point in the future.

   The United States is one of the biggest GDP spenders on digital education within OECD, determining this particular segment of education as one of the fastest growing segments of spending[17].

   However, when talking about education, a new paradigm of return on investment is introduced and qualified as SROI (Social Return on Investment), defined as non-monetary return on the investment made.

   The short-term benefits of technology in education are the cost savings fostered by economies of scale and logistical benefits in infrastructure management and development. In the medium-term, the personalization of the teaching and learning process and surge in motivation represent some of the expected outcomes. Finally, in the long run, the key impact is on the level of culture of the country.

   As a result, although difficult to calculate, we can conclude that the main costs are the total cost of owning the technological infrastructure, content, and services (initial investment and ongoing maintenance costs), while the return could be providing the right skills to teachers, families, and education leaders[18].

2. **Social imparity**

   Some of the main inhibitors of digital progress are related to social imparity, which is heavily affected by the proportion of GDP that nations dedicate to their public education. In a digitalized environment, all public institutions must develop jointly to prevent further social dissimilarities. The disjointed development of some countries may result in there being a broader range of professions that are unattainable for less economically developed countries and nations that do not dedicate enough funds to supporting steady digital progress.

3. **The need for human interaction**

   Under-conceptualized in certain web learning theories such as Connectivism[19], social and human interactions are crucial to the educative process. The majority of digital trends undermine the necessity for human dialogue and human interaction. For example, MOOCs alone might not be considered to create a lot of value for education in developed countries, as they offer quite a similar approach to learning as traditional methods and consume a lot of human and financial resources for set-up, without an evidence-based SROI.

The progress of shared platforms and live worldwide connections has allowed educative institutions and corporates to promote a new way of knowledge trading and sharing

16 European Commission. Technologies for better human learning and teaching. 2014

17 Not what it used to be: American universities represent declining value for money to their students. The Economist. 2012

18 Rivera Pastor, Rafael and Tarín Quirós, Carlota. Learning and Teaching Technology options. s.l.: European Parliament, 2015

It is important to note that learning is a process and as such it involves an evolution, which can rarely be fully achieved through a completely computerized progression. Perhaps adaptive learning could go as far as an artificial teacher. The learning path from A to B, where a good teacher knows where the student stands, is a condition that could be easily fulfilled by a computer application and could guide a virtual university where an artificial teacher could set a complex assignment in a simulated gaming environment. Despite the growing role in the deployment of teaching, the role of human teachers will be still central but changed[20].

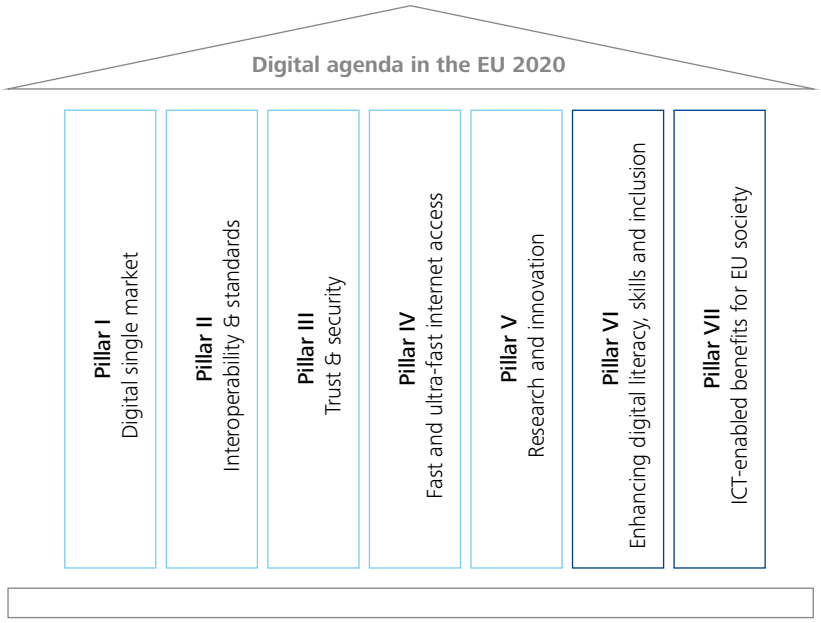
4. **Complexity and investment in teachers**
   The role of teachers, as expressed previously, will change dramatically in the coming years. Teachers will not be a sole source of knowledge but shall act as mentors and guides in the teaching path while conducting their own research to answer new questions and define new problems. The human teacher will use the artificial teacher as a tool, encouraging students to be critical of it and discuss ethical actions.

5. **Psychological impact on students**
   In recent decades, several theorists have made great attempts to address the possible issues and unwanted effects that more digitalized classrooms could bring to students' educative experience and to the cognitive senses.

   Indeed, technology has been associated with a substance of distraction, rendering its professional utilization rarefied. This rarefication, often associated with an increased level of possible distractions, can be considered as the direct consequence of the indolence that technology creates at a cognitive layer. It is for this reason that many theorists argue that a complete digitalization of the classroom can decrease effectiveness and student productivity and in the long run reduce concentration capabilities in a working environment.

Technology and education in Europe

Europe, through the implementation of its "Europe 2020 Strategy"[21] has placed a strong focus on technology and articulated its digital action plan on seven aspects, identified as pillars.



19 *Connectivism: A Learning Theory for the Digital Age. George, Siemens. 1, s.l.: International Journal of Intructional Technology & Distance Learning, 2005, Vol. 2*

20 *O'Kane, Hannah. Technology and the future of education. s.l.: Scientific Foresight (STOA), 2014*

21 *EC Commission (2012), Europe 2020 Strategy, [Online] February, 2016 https://ec.europa.eu/digital-single-market/en/our-goals*

Pillar VI "Enhancing digital literacy, skills and inclusion" aims at aligning the content of the courses and learning to the digital competences needed in the professional sector. Although enhancing digital literacy, skills, and inclusion is a goal which can and should be worked on in all stages of the lifelong learning process, it is commonly accepted that early stages of a person's educational development, specifically during childhood and puberty, allows a significant number of capacities to rapidly gain the knowledge and master the use of ICT-tools and digital skills. This is combined with the fact that young generations are de facto better acquainted with the day-to-day experience of living in the digital era.

Pillar VII "ICT-enabled benefits for EU society" underlines the necessity to invest in ICT. This is not only to create a viable ground for the realisation of Pillar VI, but also to ensure that the social parity among the countries increases. The ultimate objective is to offer the same chances to all students across Europe to develop digital competence, and to offer opportunities to attain a broader set of possible professional outcomes.

The last Survey of Schools (conducted in 2012 and published in 2013) highlighted how European schools are still lagging behind the optimal standards. In the press release following the publication of "Opening up education," the Commission informed that "between 50 percent and 80 percent of students in EU countries never use digital textbooks, exercise software, broadcasts/podcasts, simulations, or learning games."[22]

Recently, the European commission called for a new tender to conduct a survey of schools, not only to benchmark the evolution of the situation since 2012, but also to identify best-in-class countries and estimate the cost of taking other countries to their level.

Between 2012 and 2016, new policy developments and studies have been published, such as the NMC Horizon report[23], together with the development of new market technologies for digital education. Their impact on the last two pillars should be specifically considered. As such, the studies pointed out two challenges: "the changing role of school teachers as a result of ICT influence," and "the low digital competence of the students," which the experts consider to be solvable. These studies also pointed out one challenge that they consider to be more difficult: "Having students actively participating in the design of learning activities."

The European Union considered these challenges in the conception of the "Open Education Europa" to strategically approach the evolution of learning and teaching, in the context of its potential impact on the member states. Finally, the Union identified the development of open educational resources (OER) as one of the key action points to achieve its "digital revolution." As part of this initiative, a web portal was launched to enable teachers, students, decision makers, and stakeholders to access the existing digital content (OER, MOOC, eLearning's, paper journal, etc.) and exchange their experiences and comments over dedicated forums.

Conclusion

The effect of technologies and digitalization in Europe, especially due to low maturity, does not yet have a game-changer status even despite the profound influence it has. Stable growth in the rate of adoption of technology in education is paving the way for change in the education system and in society as a whole.

Knowledge sharing experiences, web-based learning activities, and significant investment should be able to create the basis for a disruptive change in education. Once the main trends have been consolidated, further steps in technology will be taken with augmented reality and virtual presence in laboratories and research centers to allow remote access to expensive tools or to enhance integration among institutions across Europe and further afield.

Despite the gap with other developed countries, Luxembourg and Europe more broadly could anticipate these trends when planning the future of the education sector and move towards a readiness to adopt new technologies and education systems designed to integrate innovative teaching systems and take on new challenges.

22 EC Commission (2012), 'Survey of Schools: ICT in Education. Benchmarking Access, Use and Attitudes to Technology in Europe's Schools'. Final Report. [Online] https://ec.europa.eu/digital-agenda/sites/digital-agenda/files/KK-31-13-401-EN-N.pdf

23 NMC Horizon (2014), "The NMC Horizon Report". The 2014 School Edition examines Edition examines trends, challenges, and technologies for their potential impact on and use in teaching, learning, and creative inquiry. [Online] http://cdn.nmc.org/media/2015-nmc-horizon-report-library-EN.pdf

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