# Leveraging International Platforms and Projects for Industry x.0 Skills in Higher Education

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**Abstract**

Merging internationalization with digitalization in higher Education is almost a natural process. The international exposure brought on by the university's digital life is, apart from a marketing tool for the institution, an essential tool to provide international, intercultural and specific technical skills. Transnational projects, such as Erasmus+-funded strategic partnerships, leverage the potential of this exposure by allowing for blended mobilities and the creation of transdisciplinary collaboration communities.

This article highlights the transformational role of Industry x.0 in higher education focusing on the unification of digital technologies such as AI, IoT, and big data in production and education. It is a brief on the transition through Industry 1.0 to Industry 4.0 and to x.0 and, therefore, why educational institutions need to transform into fourth-generation universities that offer digital literacy and data analysis competencies. The article covers the role of Erasmus+ Strategic Partnerships and European University Alliances in promoting international integration and innovation in the education. Using a comparative case study of the BLOCKS and FOReSiGHT projects, it argues that digital platforms are central in addressing the dictionary gap and transdisciplinary collaboration and resilience, essential in navigating the challenges of Industry x.0.

## 1. Introduction

Industry x.0 - the successor to Industry 4.0 - is an age of transformation in which digital technologies such as artificial intelligence, the Internet of Things, robotics, and big data analysis are integrated into manufacturing processes. That represents an evolution from conventional manufacturing to smart factories in which the emphasis is on efficiency, customization, and automation. Industry x.0 (Dev, 2023) refers to the evolution of different industrial revolutions (Simon, 2023) and is a milestone in the history of manufacturing and production. Industry 1.0 (Technical Laboratory Systems, Inc., 2023), which started at the end of the eighteenth century, involved mechanization through water and steam power, transforming textile production and altering other industries. However, it was only in the 19th century, with electrification, assembly lines, and mass production, that Industry 2.0 appeared, raising efficiency, and cutting costs significantly. The third revolution, or Industry 3.0, started in the 20th century using computers and programmable logic controllers, establishing the foundations of modern-day manufacturing processes. Now, we are in the age of Industry 4.0 (McKinsey & Company, 2022), which adds digital technologies such as the Internet of Things (IoT), artificial intelligence (AI), and cloud computing to production processes to create smart factories and continued automation (Yasemin, 2021). Industry x.0 goes beyond 4.0 while incorporating all the latter's basic principles: automation, IoT, cloud computing, data exchange, cyber-physical systems, and cognitive computing. In addition to these, x.0 brings about the integrated approach of combining flexibly and sustainably these core principles in a holistic manner to deliver value.

Concerning higher Education, Industry x.0 plays an important role as well. However, it first requires an overhaul of the educational scheme. Educational institutions must respond by teaching skills for this era's new industrial age, including data analyses, cybersecurity, and digital literacy, thus moving from "third-generation universities" to "fourth-generation universities" to meet the needs and demands of a knowledge-based society (Zuti, Lukovics, 2015). It also ensures that graduates will have the skills requested by a digital workplace.

In addition, Industry x.0 promotes more significant interaction between academia and Industry, with successful cases such as an event-driven integrative framework for manufacturing (Modoni et al., 2019) or a Professional practice program (Ashruf et al., 2021). Industrial partners are instrumental in helping universities offer internships, co-op programs, and research projects that can provide practical, hands-on experience. Such partnerships also broaden learning and enhance appreciation of the relationship between academic theory and real-world industrial applications. Moreover, industry x.0 compels higher institutions to rethink their modes of instruction. Making digital tools and platforms central to Education and adopting problem-based and experiential learning methods has become critical. Examples such as the using Virtual reality (Rojas-Sanchez et al., 2023) or virtual learning factory toolkits (Mahmood et al., 2021) are expected to become mainstream rather than anecdotic in the following years (Castro, 2019). Industries are rapidly changing, unpredictable, and constantly transforming under the Industry x.0 concept. Lastly, Industry x.0 emphasizes the importance of lifetime education. In the age of constantly evolving technology, upskilling and reskilling are both critical for development and growth. This is achieved through the innovative courses, certifications, and online learning offered by each higher education institution to keep up with the shifting demands of professionals and Industry.

The value of the Erasmus+ approach, which introduces new methods and methodologies to Higher Education in experimental programs and which includes educational work and training to develop these essential strengths, becomes thus evident. Students and professionals can only learn the skills necessary to compete in the information age through international cooperation and exchange between educational institutions. Nevertheless, upgrading Industry 4.0 skill sets makes Erasmus + part and parcel of the foundation for training the workforce needed to meet the challenges ahead. Industry

x.0 is not only a technological revolution - it has enormous potential for educational reform. Higher education institutions will have no choice but to actively respond and meet demand from Industry in the digital transformation era.

**2. Background – The context of Erasmus+ Strategic Partnerships and European University alliances**

Erasmus + Strategic Partnerships and European University Alliances (European Education Area (n.d.) ) are changing the future face of higher education throughout Europe (Souto-Otero et al., 2019, EURAXESS, 2020). The European strategy for establishing universities strives to build up 60 alliances of European Universities, calling together more than 500 higher education schools, expected by mid-2024. They are transnational alliances of higher education institutions forging a new frontier toward internationally integrated universities. Funding is essential, mainly from the Erasmus+ program for these alliances (European Education Area (n.d.) ). The program encourages establishing and running alliances among European universities, with applications for funding on Education and the connection between Education, research, and innovation to meet societal needs. The large budget allocation for the Erasmus+ program is to be dispersed until 2027 on calls focusing on using current deep institutional transnational cooperation alliances.

All the various alliances between European universities make several advantages possible, such as quality and comprehensive education as well as research and innovation (European Education Area (n.d.) ). These are in harmony with current trends in digitalization and sustainability and are designed to help solve critical social problems. University alliances in Europe play a crucial role in shaping the higher education landscape, driving innovation (Fedak et al., 2022), and fostering international cooperation while acting as new relevant players in the multi-level governance of higher education policies (Vukasovic & Stensaker, 2018).

European inter-university campuses are a particular type of alliance providing mobility for students, doctoral candidates, and staff. This can be both physical or online attendance or blended learning. Upholding the principles of interdisciplinary and cross-sectoral cooperation, they encourage flexible, creative curricula attentive to student needs. Furthermore, these alliances promote practical work opportunities and apprenticeships. All of this serves to strengthen civic participation, entrepreneurship, and inter-sectoral learning. European University alliances also strive to form teams to produce knowledge within Europe. The challenge-based approach these teams adopt means that all the problems are related to real-life issues, and their solutions can be implemented. In addition, Horizon 2020 (European Commission, 2020) gives these alliances extra assistance for their research and innovation objectives. This support has helped the universities integrate and transform research and innovation to increase international competitiveness. Funding from Erasmus and Horizon 2020 is an essential factor that helps create ever closer relationships between the European Education Area and the European Research Area.

The Erasmus + Strategic Partnerships are also helping to facilitate the development of programs connected with Industry 4.0. Within the framework of the Erasmus+ projects, the objectives related to Industry x.0 are a core development line: fostering competencies and skills for digitalization, in line with transnational cooperation and integration of innovative teaching methods and methodologies. Assante et al. (2021), Gleich et al. (2019) and Poszytek et al. (2022) present various examples of best practice in connecting Erasmus+ with Industry x.0 elements, from open educational resources to collaborative learning platforms and their challenges during uncertain times.

Erasmus+ Strategic Partnerships are collaborative projects aimed at fostering innovation and exchange of practices in Education, training, and youth sectors across Europe. These partnerships involve various stakeholders, including schools, universities, and NGOs, to develop, share, and

transfer best practices and innovative educational approaches. These partnerships aim to promote using technologies such as the Internet of Things, artificial intelligence, robotics, and data analysis in schools and industries. This integration is essential for upgrading industrial processes, raising productivity, implementing predictive maintenance, and driving entrepreneurial innovation. Industry x.0 projects, such as the ones mentioned in Rojas-Sanchez et al. (2023), Mahmood et al. (2021) or Castro (2019) can only succeed with close cooperation between Education and Industry. This includes interaction with industrial players, such as companies, research institutes, and business associations, to enrich projects with experience and support resources. Such partnerships encourage knowledge sharing, skills development, and the co-creation of new solutions. The acquisition of digital skills to adapt to the Industry x.0 environment is a common theme of Erasmus + projects in this context. Such skills include programming, data analysis, cybersecurity, and problem-solving.

## 3. Digital Transformation and the Evolution of Industry X.0: A Literature Review on Bridging the Skills Gap

The role of European citizens as transnational creators of value is highly facilitated by digital technology, as this allows for problem-based and interactive learning and thus enables personalization of the learning experience by skills and objectives. The evolution of digitization and mitigating risks related to global supply chains has highlighted the lack of skills and resilience worldwide (Durach et al., 2020). It has also shown a remarkable capacity for flexibility and agility at the micro level. The three phases of automation (from the rigid implementation of the 70s to the flexible version of the 200s and the current "intelligent automation") raise new challenges for the capacity of the citizens and companies to align to a new reality in which the correct and streamlined blend of work done by people and machines brings in more resilient competitiveness. Intelligent automation may bring increased resilience and higher flexibility in a VUCA world. Still, skills are needed for these objectives, while the apparent mismatch between technological evolution and human capital may lead to unemployment (at least in the short term). There are figures to support this statement:

350,000 EU vacancies in highly skilled technical expert jobs and a highly uneven level of businesses' digitization, with about 77% of EU workplaces reporting a digital skills gap lacking in undertaking any actions (SWD (2018) 305 final). By tackling this noticeable digital skills gap within the EU, our project also focuses on addressing and contributing to the European Higher Education Area's commitment to exploiting the potential benefits of digital technologies. It does so by strengthening the European efforts to address the challenges that higher education systems currently face: graduates whose skills are irrelevant in the labor market, fewer opportunities in research, or significant back-log in innovation within higher education institutions and the economy.

Blockchain has become the buzzword for disruptive innovation in the past few years, potentially impacting all services and products. In its technical name, DLT (distributed ledger technology), it is the sharing and recording of information, secured by cryptography, updated and maintained by a network (of computers) instead of a central node. Governed by decentralization, blockchain is perceived as exciting but potentially disrupting policies, financial services, inclusion, intellectual property, manufacturing, energy, supply chain, IoT, social impact issues, and policies. Blockchain is projected as an internet of value (as opposed to the internet of information) by the World Economic Forum (June 2017) and is immutable, public, historical, and inclusive. All these characteristics are suitable for a direct connection to entrepreneurship. The disruption to the traditional way of doing business by the digital transformation (DX) is enhanced by the redesign of the value chain, the reshaping of the workforce's skills, and the retooling of the value proposition from the entrepreneurs. The new entrepreneur needs knowledge about the components of this DX: design thinking, robotics, big data,

analytics, IoT, additive manufacturing, cryptocurrencies, and blockchain to foster all the benefits of DX and to enhance the value proposition sustainably and resiliently.

Following the remarks of the EC within the proposal of "A New Skills Agenda for Europe" (COM (2016) 381 final), we are acknowledging the fact that new ways of working emerging from the Digital transformation process are affecting the types of skills needed, including innovation and entrepreneurship. As EC acknowledges in the working document accompanying its proposal for the Digital Education Action Plan ({COM (2018) 22 final}). However, all sectors of Education are increasingly making use of digital technologies to stimulate educational innovation, "there is a long way to go before the full potential as a tool for learning and teaching is reached" as "the impact of technology in changing educational practices is currently less evident than it was hoped for." From another perspective, research and innovation are economic growth engines; cultivating an inclusive environment where science and entrepreneurship meet helps us ensure an innovation pipeline that views today's challenges as tomorrow's opportunities. Technology and knowledge transfer play a decisive role in driving this process by bringing academic and institutional research to the market and Society as innovative products and services with an economic and social value attached, generating economic growth and value for Society. Unlocking the potential of technology transfer is critical to improving European innovation, particularly in the CEE countries.

As internationalization becomes a reality in higher Education, digital collaboration platforms are becoming more and more useful for cultural interchanges and skills related to employability (Starcic et al., 2017; Standley, 2015). The trend is strengthened by the appearance and further acceleration of use due to the COVID-19 pandemic (Che Ahmat et al., 2021; McGreal et al., 2022) of micro-credentials like digital badges which provide flexible and accessible learning (Lemoine, 2015). Nevertheless, the success of such efforts hinges on the responsiveness of each institution to global trends and its effectiveness in safeguarding the quality of cross-border Education (Olcott, 2009; Teichler, 2009; Serpa et al., 2020).

The aspects related to the Industry x.0 skills in higher education hinge on two aspects:

- the Problem aspect - Industry x.0 (and all aspects related to skills) and
- the Solution aspects (internationalization, digital collaboration platforms, micro-credentialing), to be further explored in the following sub-chapters.

### 3.1. The "Industry 4.0" angle or the Problem

The development of Industry 4.0 brought new challenges to Higher Education, a sector known for its rather un-agile approach to change. Baygin et al. (2016) and Menezes & Pinto (2016) emphasize the need for conformity to local demand, and in particular, **a need for university-industry liaison**, as the level of knowledge of concepts, mechanisms, and theories is reduced (Mokhtar & Noordin (2019), AlMaadeed & Ponnamma (2020)). While authors like Beke (2020) note that **Industry 4.0 is demanding a whole new model for the economy**, Gaol et al. (2018), Vetiska et al. (2020), and Fahim et al. (2021) all look at **new learning models and modes of instruction**, such as Interactive technologies and Smart Education, that involve Industry 4.0 technologies and digital ideas.

On the road to Industry 4.0 Skills Integration, synthesizing major educational theories in a genuinely comprehensive fashion means adopting **a multi-dimensional approach** that syncs with industrial sector demands that are changing at a growing rate. Industry 4.0 technologies, including augmented reality, simulation, Internet of Things, and virtual reality, were mainly used in higher Education, as described in Moraes et al. (2023). All these technologies help students to learn by increasing

engagement, encouraging interpersonal communication, giving the students a feel for real-world conditions, and cultivating soft skills that Industry 4.0 will require.

Also, reviews of international literature (Chakraborty et al., 2023) stress that **educational models ought to be designed around combinations of the various competency and capability function domains that best meet the demands of Industry 4.0**. Based on survey results, Chakraborty et al (2023) determine that essential elements of Education 4.0 are decision-making, entrepreneurial thinking, efficiency orientation, problem-solving, conflict resolution, and analytical skills. In addition, another "integrated alignment model" was advocated, in which educational activities are aligned with the needs of industries within the framework of Industry 4.0, and the relationship between connectivity, automation, operation, and intelligence can be brought together. Singapore sets an excellent example with its Smart Industry Readiness Index (SIRI), which road-mapped and planned the architecture for successive phases (Singapore International Centre for Industrial Transformation, 2024). It shows the urgency of a comprehensive and proactive inventory of diverse competencies in Education to match the substantial and constantly changing needs of the Industry 4.0 era.

A fundamental part of Industry x.0, **digital platforms** bring opportunities and leverage challenges for higher Education, enhancing teaching, learning, research, and governance (Bygstad et al., 2022). Although particularly relevant to the transition to digital universities (Shrivastava 2022), the use of platforms in transfer and research is still underrepresented (Reiche, 2022), while the adoption of digital technologies (cloud, mobile, virtual) is seen as essential to a more efficient and effective educational process (Uimanova & Bilalova, 2021).

Starting from the linguistics term of "language gap" (Johnson, 2015), we define the dictionary gap as part of The Problem and as a discrepancy in terms and concepts between tech and non-tech professionals, stemming from either superficial understanding of common concepts or homonymic terms. For instance, this dictionary gap became evident during the implementation of a current Erasmus+ project, BLOCKS, as basic concepts such as 'value,' 'currency,' and 'trust' were found to be understood fundamentally differently by economists and IT specialists from various organizations. This misunderstanding represents a critical vulnerability in a society transitioning to digitally based. In a nutshell, no platform allows for foresight, resilience, risk management (RM), digital transformation (DT), and algorithmic governance (AG) to be put together in an easily accessible way for all stakeholders.

The dictionary gap is also supported by literature, as it has been a conversation topic for decades. For instance, Trower & Straub (1992) and Murphy et al. (2019) emphasize the importance of differentiating between tech and non-tech, with Trower proposing an instrument to do so and Murphy et al. advocating for a new lexicon. Medlin et al. (2001) and Canada and Brusca (1991) discuss the importance of nontechnical skills in the tech industry and the technological gender gap.

As a conclusion that aligns with the cases used in this paper furtheron, Christensen (2012) argues that bridging the dictionary gap between tech and non-tech can be achieved through cross-cultural collaboration and enhanced training and support systems. The technological aspects related to Industry x.0 are making these two paths achievable.

### 3.2. The "internationalization of higher education" angle – or The First Part of the Solution

Merging internationalization with digitalization in higher Education is almost a natural process. Although the internationalization process of higher Education began several decades before the latter, worldwide exposure in all its components has frequently coincided with technological advancement. Over the last 50 years, the process of internationalization of higher education has been marked by

significant trends (from massification to the Global Knowledge Economy), evolving at the level of higher Education: experiencing a shift in perspective from a narrow range of marginal and often ad hoc activities to more comprehensive processes and central policies, in the context of a gradual shift from mobility of individuals to mobility of study programs, internationalization has become a critical strategic agenda for both universities and local and national governments across the globe. Today, this process involves an extensive range of players inside and outside the educational system. It is motivated by a vast and diverse range of organizational, programmatic, and reasoning techniques.

There are various perspectives linking internationalization with digitalization in higher education, such as:

- Virtual Internationalization Framework: as proposed by Bruhn (2017), it includes virtual mobility, Collaborative Online International Learning (COIL), and virtual transnational education (TNE). These are practical means of depicting the natural process of merging international and digital efforts.
- Digital Learning Platforms and Internationalization: digital learning platforms have significantly contributed to the diversification of the higher education landscape, focusing on the increase of competitiveness and improvement of skills (De Lima et al., 2020)
- Digital Inclusion and Equity: (Wimpenny et al., 2022)
- Digital Transformation in Higher Education: limited use of digital technology for predominantly assimilative tasks, with Learning Management Systems perceived as the most helpful tool, indicating a need for strategies to support broader educational technology use (Bond et al., 2018).
- Facilitating Learning through International Virtual Collaborative Practice: the potential of digital platforms to facilitate 'internationalization-at-home' paradigms, promoting inclusivity and global engagement (Wihlborg et al., 2018)

From a typological perspective, we are dealing with two major components that define the same concept which enhances learners' access to global learning: internationalization at home (campus and curriculum internationalization, teaching and learning, joint programs, intercultural and international competencies, and learning outcomes) and internationalization abroad (student degree and credit mobility, short-term student and staff mobility, and study program mobility) (Soria & Troisi, 2014, Harrison, 2015, Spencer-Oatley & Dauber, 2020, Mittelmeier et al., 2020).

The various critical approaches of the last 20 years that have aimed at correcting the relatively narrow perspective of the concept should be discussed here: thus, to counter the exclusive focus on mobility, movements such as "Internationalisation at home" (Beelen & Jones 2015), "Internationalisation of the Curriculum" (Leask, 2015) and "Comprehensive Internationalisation" (Hudzik, 2015) have tried to shift the perspective towards an internationalization process that addresses all students, not only the highly mobile ones. As a result of the observation that mainstream approaches exclusively addressed one of the university's three missions—Education—movements centered on research and society have also arisen. These include the "Internationalization of Research" (Woldegiyorgis et al., 2018) and the "Internationalization of Higher Education for Society" (Jones et al., 2021). As it becomes clear that the concept of internationalization of higher Education is complex and ever-evolving, we must now redefine it in light of factors like study abroad, international students, internationalization at home, transnational and cross-border Education, digitization, and the use of particular terminology like "global citizenship."

Internationalization is not a one-size-fits-all model, as its diversity is found at institutional, local, national, and regional levels, and is, in fact, a concept that has evolved and changed over time in response to changing challenges and contexts: moving from the "international education" fragmented and ad-hoc perspective to that of the process of internationalization – with the emphasis on the process approach (Knight's 1993 and 2003 update definition of internationalization), and beyond, leading to new and more insightful perspectives on the concept. De Wit et al. (2015) give a fresh and more inclusive definition of the process in their Study to the European Parliament: "the international process of integrating an international, intercultural or global dimension into the purpose, functions, and delivery of post-secondary education in order to enhance the quality of education and research for all students and staff and to make a meaningful contribution to society." (De Wit et al. , 2015)

Global involvement, which focuses more on the concept's collaboration, networking, and partnership aspects, is a word used interchangeably with internationalization within the same conceptual framework, and the European Universities Initiative previously discussed in the paper is also based on this approach. As internationalization efforts involve promoting diverse learning pathways and experiences, the evolving landscape of Education in this globalized world brought to the fore a tool adapted both to the new paradigm of internationalization and to the new perspective determined by Industry x.0: micro-credentials. Micro-credentials and internationalization in higher education are related because they both aim to provide flexible learning paths, foster cooperation and lifelong learning, and prepare students for a globalized environment. Both ideas adapt to the changing needs of Education and the dynamic demands of the contemporary workforce.

Micro-credentials are multipurpose, creative 'just-in-time' upskilling and reskilling solutions that seek to close the skills gap in Education, research, and the job market (OECD, 2023). Micro-credentials are recognized short-term learning experiences, such as short courses or training on cutting-edge information to get the necessary skills, know-how, and competencies, which can take place in a real classroom, online platform, or virtual space. Micro-credentials are intended for many learners, including students, graduates, lecturers, researchers, and other stakeholders, such as industry representatives and public groups. They provide a flexible and focused approach to assisting learners in developing the information, skills, and competencies required for their educational, personal, and professional growth. (Council of the European Union (EU), 2022).

**4. The Methodological approach**

This research adopts a comparative case study methodology examining two initiatives that have developed one digital platform for international learning and collaboration. The "central hypothesis" of our investiagtion is that these digital (and internationally available) platforms can mitigate the systemic vulnerability associated with a "dictionary gap" - the lack of shared lexicon, terminology and understanding, a weakness frequently exacerbated by cultural differences.

For this purpose, we have chosen two Erasmus+ Strategic partnerships projects spearheaded by the Bucharest University of Economic Studies, Bucharest, Romania. The projects, implemented in a 5-year timeframe between 2018 and 2023, reflect different environments and methods of building digital partnerships to produce cross-disciplinary and cross-cultural collaboration. The two projects chosen are

- BLOCKS – Blockchain for Entrepreneurs – a non-traditional Industry 4.0 curriculum for Higher Education (2018-1-RO01-KA203-049510) – Further details may be found at https://projectblocks.ro/ and

- FOReSiGHT - Flexibility and Resilience in Digital Transformation and Intelligent Automation – Advanced Skills and Tools for Academia and Entrepreneurs (2020-1-RO01-KA203-080368) - Further details may be found at https://www.erasmusforesight.ro/ ,

The case analysis focuses on the description of the projects, the link between them through the digital platform (the BLOCKS Platform - https://platform.blocks.ase.ro/)

FOReSiGHT scaled the platform developed under BLOCKS (from 1000 to 4500+ users) by adding courses and webinars focused on DT, IA, AG, RM, and resilience and allowing for a more systemic approach as well as a larger view of skills to be developed for the future—lessons learned on curriculum development.

The analysis relies on projects documentation, digital platform and content analysis and usage statistics and analytics as methodological instruments to assesses how the collaboration platform deals with language and culture issues, promote knowledge exchanges, and encouragess endurance in cross-disciplinary cooperation. We contrast approaches and results in dictionary bridgebuilding and identify best practices in bridging interdisciplinary and intercultural gaps, informing resilient platform design for Industry x.0 environments.

The findings contribute to the discourse on creating digital platforms to bridge inter-disciplinary and inter-cultural spaces, thus making Industry x.0 spaces even more resilient.

## 5. Platform.blocks.ase.ro – a case study in international digitally leveraged collaboration platforms

### 5.1. Summaries of Projects BLOCKS and FOReSiGHT

#### 5.1.1. Project BLOCKS

The BLOCKS project created a networked platform of collaboration on curriculum development for universities and companies to develop non-traditional, blended-learning courses tailored for an Industry 4.0 world and focused on providing teachers, students, and entrepreneurs with knowledge and skills on blockchain technology. The approach was non-technologically intensive, as the purpose was to provide a business-oriented type of knowledge applicable to all types of students and entrepreneurs.

The project identified critical skills and knowledge packs needed in a blockchain-powered economy. It implemented them in the university curriculum in a gamified, user-design-oriented manner tailored for various users.

The specific objectives of the project were:

1. Identification of skills shortages and knowledge gaps in blockchain in target groups

2. Creation of an online multidisciplinary transnational teachers training center on the blockchain

a. Design and development of a curriculum on blockchain for teachers and trainers

b. Design and creation of digital, online delivered, gamified study materials on blockchain for teachers and trainers

3. Design and development of blended learning curricula on blockchain for students, entrepreneurs, and other types of users

4. Design and creation of digital, online delivered, gamified study materials on blockchain for students, entrepreneurs, and other types of users

5. Design and development of a BLOCKS game – a preparatory online learning tool designed to provide users with learning opportunities in preparation for using a platform such as Microsoft Azure–Blockchain as a service.

BLOCKS was implemented by a consortium of 7 universities, large enterprises, and SMEs from Romania, Estonia, Greece, Latvia, and Italy. It instructed more than 400 trained professionals in blockchain-related issues: students in the partner universities, teachers, trainers, entrepreneurs, and professionals in other ecosystem actors (financial, regulatory, etc.).

The project's transnationality derives from the blockchain's very essence: decentralization. The project benefits from each country's experiences, educational policies, and specific knowledge and tech transfer practices. The interaction between diverse, experienced partners led to a unique clustering of resources and attitudes, creating the proper environment for approaching a disruptive topic suitable for Industry x.0.

**5.1.2. Project FOReSiGHT**

Like the dictionary gap in the blockchain discourse, the lack of trans-disciplinary conversation, particularly in higher education at the nexus of resilience, foresight, risk management, digital transformation, and algorithmic governance, was the key driver for the FOReSiGHT project. The project was created in response to a specific need for the link between theory and practice in an international collaborative platform, facilitating the interaction and understanding between specialists in various fields, particularly those related to digital transformation, in general, and shifts in business models caused by Industry x.0. The increasingly rapid pace of technology, which causes new risks and opportunities for businesses and societies, the lack of horizontal skills and knowledge of basic concepts, the demand for a broader view on resilience and the acute requisite for foresight skills were all vulnerabilities identified in both literature and previous projects and mitigated by FOReSiGHT. In 2023, as the discussion of artificial intelligence intensified, these have become even more critical needs related to an urge for the right kind of know-how to keep up with a surge of activity not previously seen in the history of Industry x.0.

The FOReSiGHT project's main goal was to build a digital platform for collaboration between universities and companies, aiming to prepare for future skills in areas like intelligent automation (IA), digital transformation (DT), and algorithmic governance (AG). Partners in Romania, Italy, Germany, Croatia, and Belgium delivered it. The result is impactful not just throughout the partners but via the delivery of the Open Education Resources (OER) via the existing online learning platform to the other platform users at European and international levels.

The project had four specific objectives linked to creating and delivering a kit for each of the three areas: DT, IA, and AG, and one Foresight Kit for Teachers, Students, and Entrepreneurs. These kits were designed for teachers, trainers, and users to develop specific skills in specific areas via blended learning methods. The activities to reach these goals included joint staff training sessions, blended mobility programs, and intensive study programs for students and stakeholders.

Transnationality was vital in this project for three reasons: First, to lessen foresight bias by integrating diverse disciplines and viewpoints. Secondly, to address the biases existing between countries having different cultural and economic backgrounds. Lastly, to leverage unique educational practices, knowledge transfer, and technology from different countries.

**5.2. Impact of Projects BLOCKS and FOReSiGHT**

The main impact of both projects is the creation of the BLOCKS Platform, with more than 4000 unique users worldwide by the end of 2023.

The platform allows for a **virtual manifestation** of international collaboration, providing the framework for shared knowledge between a diverse group of professionals, teachers, and trainers from Romania, Germany, Belgium, Croatia, Greece, Estonia, Latvia, and Italy.

Whether locally or nationally, the BLOCKS project has reached more than 1700 individuals, building up a scalable network of knowledge that matches the decentralized spirit of blockchain and raising competencies in DX and blockchain.

Key achievements include:

- Personalized education on blockchain via modular access to educational content and the promotion of individualized learning paths.
- New learning tools and techniques, however--e.g., the BLOCKS game for real-world blockchain implementation.
- Improved curricula in partner institutions while addressing market needs in blockchain education.
- Increased resilience in various stakeholders (businesses and public administration)
- Increased knowledge on blockchain, fostering entrepreneurial initiative and reducing the risk of misinformation.

Project BLOCKS has, therefore, transformed educational methods, business routines, and popular attitudes, enabling people to acquire the knowledge they need to tackle the digital age.

More than 12,000 stakeholders around Europe have benefited from the work done by the FOReSiGHT project. Resilience and forward-looking capabilities were bolstered for Digital Transformation (DT), Intelligent Automation (IA), and Algorithmic Governance (AG). With its easily curriculized modules and online content, it has provided personalized education and improved students 'DT, IA, and AG abilities. This strategic initiative has led to:

- Students and instructors acquiring specialized knowledge that may assist entrepreneurial endeavors and risk management in high tech.

- Higher education institutions also improve curricula, revealing how this project has become part of coursework.

- Cultivating digital resilience So how are businesses and public authorities likely to change their operational strategies to survive in the wake of digital disruption?

- Widespread influence on members of the public, heavy use of webinars, and online access.

These core values of competitiveness, resilience, and adaptability stem from the nature of the project--a core European strength--and the ecosystem in which it is implemented--the FOReSIGHT consortium. The empowering force behind the consortium is the ecosystem of major European universities and tech companies working together to develop humanized technologies. The com project has helped build a community whose members are poised to address 21st-century challenges. Thus, more students are doing theses related to DT, IA, and AG, and some participants have developed new business lines. As a result of this engagement, we have seen enhanced innovation ability, a closer relationship between academia and industry, and cultivating a workforce with an eye to the future.

Overall, the BLOCKS platform lists at the end of 2023, more than 7000 registered users, accessing 93 courses in 5 different categories in English, Romanian, Greek, German, Italian, Estonian, Latvian, Croatian:

- Technical oriented - 23 Courses
- Business oriented – 31 Courses
- Macroeconomic oriented – 9 Courses
- Industry based – 13 Courses
- Miscellaneous – 17 Courses

Based on student participation (number of views), courses in Greek had the most impact. In relation the number of enrolments, the courses in English had the highest reach.

In a weighted assessment, the courses in Estonian had the greated impact (most views for the longest time for the largest number of enrolled students).

The BLOCKS platform responds to aspects on the impact of digital learning platforms in at least 7 ways:

A. Fosters Competitiveness: The platform uses a competitive advantage from a cluster of top universities and technology companies based on core European strengths. This synergy is likely to provide state of the art content and practical applications that make the platform's offerings quite competitive.
B. Promotes Resilience and Adaptability: The platform promotes the creation of humanized technologies that are flexible to the changing market requirements and capable of withstand future challenges. This is because it meets the requirement for digital platforms to be resilient and adaptable, characteristics required of platforms in an Industry x.0 environment.
C. Encourages Innovation and Industry-Academia Collaboration: The platform provides advanced innovation capabilities by connecting academia and industry. This type of cooperation is essential for creating the employees body knowledgeable in present-day technologies and approaches.
D. Supports Workforce Development with a Future Orientation: The community of the platform is actively involved in solving modern challenges through theses and projects related to Digital Transformation (DT), Intelligent Automation (IA), and Algorithmic Governance (AG).
E. Community and Network Building: The platform has 7,000 users and 93 courses, which shows a strong reach, which means a large community of learners, teachers, and professionals has been formed.
F. Measurable Impact and Success: The fact that students finalize theses and participants create new business lines implies that the platform has a real effect on the academic and professional life of its users.

G. Resource Diversity: 93 courses represent diversity of subjects and learning possibilities leading to attracting a wide audience with different interests and requirements making the platform more relevant and inclusive.

**6. Analysis and Discussion. Best Practices and Strategic Recommendations**

The projects successfully provided answers and solutions to several core questions related to digitalization, higher education and Industry x.0:

**Why do we need Flexibility and Resilience Skills?** This focus on digital transformation and developing new technologies is not surprising. A company's ability to not only keep up with changing technology but also **innovate** is essential for remaining competitive. This need, however, can cause issues. Resilience and catastrophe (or disaster) recovery are commonly seen as an operational cost of operation rather than a source of profit or driver of value. By definition, resilience and risk management imply redundancy, which is in direct contradiction to efficiency and nimble competitiveness. Digital innovations are often seen as value generators, while RM and resilience are seen as a cost rather than an investment. However, reaching KPIs and avoiding technical changes and tech disruptions are very closely related.

This emphasis on DT (digital transformation) and the advancement of emerging technology is not unexpected. The willingness of a organization not only to keep pace with changing technologies, but also to evolve is necessary if it wants to stay competitive. However, this need will create problems. To tackle these challenges, as well as mitigate systemic risks and achieve systemic resilience. Definitions of resilience (Hosseini et al, 2016) abound in literature, as well as insights into systemic resilience (Lundberg & Johansson, 2015, Helfgott, 2018). This is necessary to remember how many areas such as resilience and flexibility would still need to be changed while undertaking a digital transition. Poor resilience means that all the gains in competitiveness brought by tech may be lost due to implementation costs, disruption to reputation, loss of sales and loss of consumers, or infringement of public rights (As is the case with algorithmic governance). Organizations now need the latest technologies to distinguish themselves, but they also need to be robust enough to sustain such levels of operations. When it comes to DT, flexibility is key to realizing the advantages of revenue-driving practices. Therefore, the issues related to which skills may be developed, at which level, in order to resolve such a conundrum are at the forefront of organizational decision-makers globally.

**Usecase on Flexibility and Resilience:** Project BLOCKS: The digital platform created by BLOCKS was central in promoting flexibility through the provision of a gamified, user-design-oriented curriculum, which was adaptable to the diverse requirements of user groups. It is this adaptability that is a core feature of flexibility. The resilience aspect was integrated in the curriculum's concentration on blockchain technology that is in itself decentralized and resilient in nature. The project helped professionals to be trained in blockchain-related issues, thereby, creating a workforce that is immune to misinformation and adaptive to technological changes.

**Usecase on Flexibility and Resilience:** Project FOReSiGHT: The digital platform of FOReSiGHT was created to foresee and get ready for future skills in the areas like intelligent automation and algorithmic governance. Through the delivery of Open Education Resources (OER) and blended learning opportunities, the platform proved to be the backbone of education that allows the students and professionals to continue learning and adapt in the face of swift technological changes and any potential disruptions.

**Why do we need Foresight Skills?** Foresight skills are transversal skills, critical in any form of strategic and long-term planning. They are particularly relevant in the context of emerging socio-technological domains, which are marked by high degrees of uncertainty and complexity. The EU already has a history of using foresight as a tool in preparing policies in various fields, and some member states have dedicated bodies at government level tasked with deploying foresight activities. The domain of digital transformation and intelligent automation is a very dynamic field, both in terms of technology push and the behavioral changes associated with the adoption of these technologies. Navigating this complexity requires a future-oriented framework (with clear time horizons and system boundaries) in which the drivers of change are analyzed systematically in terms of likelihood and impact; they are combined into probable scenarios of evolution, from which visions of proper action can be deduced.

Beyond nurturing individual skills, the foresight framework creates the premises for intelligence gathering, structured dialogue and consensus building regarding the likelihood of future events, and eventually the elaboration of shared visions, inspiring various stakeholders for action. An example in action, linking the two projects is this report by JRC (2019) on Foresight and anticipatory governance can enable better policymaking on blockchain.

**Usecase on Foresight Skills:** Project FOReSiGHT: By dealing with the lack of trans-disciplinary dialogue, FOReSiGHT introduced a digital platform which enabled professionals from different areas to talk and share their thoughts, thereby, advancing foresight skills. The tool provided a prospective approach for the users to analyze change drivers systematically and develop plausible action scenarios. Such a proactive approach is very important in the current complex and changing socio-technological domains.

The BLOCKS and FOReSiGHT initiatives are early cases of integrating new digital technologies into educational and professional development contexts. Despite focusing on blockchain technology, BLOCKS successfully filled the blockchain talent shortage in the European blockchain ecosystem through gamified, user-oriented curricula in university courses and professional training programs. BLOCKS has upgraded the talents of students, teachers, and professionals interested in blockchain applications, implementing the blockchain spirit of decentralization in practice.

In contrast, however, to address specific trends, the scope of FOReSiGHT includes the broader topics of digital transformation, intelligent automation, and algorithmic governance. Its influence is even broader, providing digital materials and individually tailored learning modules to more than 12,000 European stakeholders.

The two projects simultaneously had to overcome the problem of bringing technical skills in harmony with practical applications in a multifarious cultural and educational environment. With its relatively low technological bar, BLOCKS needed to figure out how to demystify blockchain technology so that nontechnicals could interact. In contrast, the task before FOReSiGHT was to bring these multidisciplinary perspectives into the foresight and resilience modules.

These difficulties also presented opportunities, including encouraging interdisciplinary research and upgrading digital knowledge nationwide. Instructive comparisons clearly show that while BLOCKS was more specialized in understanding blockchain technology, FOReSiGHT took a more comprehensive perspective on futures thinking and digital transformation.

The best practices taken from these case studies include gamification of educational materials to make them user-centered, thereby significantly improving retention of information. Also effective are the blended learning models that mix online and offline instruction. These two projects served as tangible examples of the value of transnational cooperation.

The constantly changing needs of Industry x.0 require higher education institutions to have a hybrid approach that combines dynamic digital materials on the Internet with the development of cross-disciplinary courses to keep pace. Working hand in hand with industry, developing international collaboration platforms, and fostering a culture of lifelong learning and creativity are essential aspects of this effort and are crucial to maintaining the practicability of course content.

**Conclusion and Implications for Stakeholders**

In sum, applying Industry 4.0 skills to Education must take an all-round, flexible approach, focus on both hard and soft skills, and use new technologies and industries to create simulated real-world experiences. How closely industry needs can arrange educational theory is vital to enable students to confront the challenge of the constantly changing industrial environment.

In conclusion, the only resilient path to mitigate the dictionary gap between tech and non-tech is to create authentically international digitally leveraged collaboration platforms. These platforms allow for a genuinely transnational approach (beyond the internationalization scope) by reducing bias and providing a continuous conversation between teachers, students, and researchers. Moreover, the collaboration process stems from each country's perspectives and activities, with their unique knowledge transfer and technology interaction. These international digital skills platforms provide a diverse ecosystem with various actors. The presence of these actors in countries with different policy approaches to Education, knowledge transfer, and technology as a business opportunity, as well as the uniqueness of each actor, enables a unique pooling of knowledge capital, cultivating the proper ground for an inventive approach to a transdisciplinary topic.

The BLOCKS and FOReSiGHT projects offer key strategic insights and recommendations for integrating digital platforms within the higher education and professional development sectors:The BLOCKS and FOReSiGHT projects offer key strategic insights and recommendations for integrating digital platforms within the higher education and professional development sectors:

Developing Flexibility and Resilience Skills:Developing Flexibility and Resilience Skills: Initiatives such as BLOCKS and FOReSiGHT demonstrate the value of adaptability and sustainability in education and professional development. They demonstrate that in a fast-changing technological environment, people and companies have to be able to adjust to new instruments and conditions rapidly. The gamified, user-oriented curriculum on blockchain and the focused skilling in DT, IA, and AG develops an agility to pivot and adjust to market changes. Flexibility is embodied by the platforms themselves that enable modular and customized learning.

Embracing Gamification and Blended Learning:Embracing Gamification and Blended Learning: Both projects have demonstrated the efficiency of gamified content and blended learning approaches in engaging learners and improving the learning process.

Supporting Humanized Technology Development: Humanized technology development attention to digital platforms that not only address technical issues but also take into consideration the human side of technology adoption and integration.

Cultivating a Future-Oriented Workforce: The projects with theses and projects related to DT, IA and AG, emphasize the need for an educated workforce that is not only competent with the existing technologies but also the one that can anticipate and shape the future development.

The Erasmus + projects BLOCKS and FOReSiGHT provide evidence that genuinely international, digitally-centred collaboration platforms can bridge the "dictionary gap" between people specializing in different fields. These platforms allow for a transnational outlook, going beyond internationalization by reducing bias and ensuring constant communication between teachers, students, and researchers. Simultaneously, these platforms offer an appropriate setting for the design and development of micro-credential certification programs. Since these programs are primarily intended to be delivered in a hybrid context, we presume that the platforms' functionality and curriculum design complement each other well. It is possible to meet the requirements and expectations of academics, stakeholders, and learners in this way.

The implications for stakeholders are significant: Only by accepting such digital platforms can teachers, industry workers, and policymakers come together to realize transdisciplinary learning and cooperation. This is essential for building a skilled workforce that understands and participates in the new world of industry x.0.

*DISCLAIMER: This article uses the project description elements (such as goal, objectives, and activities) from the Erasmus+ applications of the two projects, as the authors wrote them in the precontracting stage. These were maintained in this article as such.*

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