DIGITAL4Business: Mastering Advanced Digital Skills for European Business Transformation

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Abstract. The DIGITAL4Business project is a major European initiative aimed at addressing the advanced digital skills gap by delivering an innovative Master's programme in digital competencies tailored to the demands of the European industry. This paper presents the DIGITAL4Business' structure, objectives, Master's curriculum design, and findings from a comprehensive needs analysis that identifies critical skills requirements in cybersecurity, artificial intelligence, cloud computing, and data science. Developed by a consortium of academic and industry partners, the 60-ECTS-credit programme is formally titled *Master's Degree in Advanced Digital Technologies for Business* and is jointly delivered by four leading European higher education institutions. It provides European businesses with a digitally proficient workforce capable of driving digital transformation across various sectors. Designed for broad accessibility with pathways for diverse learners to engage in cutting-edge Education 5.0, the flexible Joint Master's curriculum comprises 14 modules and is accredited at European level. Key recommendations and future directions aim to optimise the impact of the programme on Europe's digital transformation, with a focus on sustained adaptability to emerging technologies and collaborative partnerships.

Keywords: Digital Transformation, Advanced Digital Skills, ICT Skills Gap, Postgraduate Education, Education 5.0

1 Introduction

The digital transformation of the business sector has emerged as a key priority in ensuring the competitiveness of the European Union (EU) in a globally interconnected economy. Recent data indicate that while European businesses increasingly adopt digital technologies, a significant skills gap limits the effective implementation of these technologies, particularly within small and medium enterprises (SMEs). According to the European Commission, Europe will require approximately 20 million information

and communication technology (ICT) professionals by 2030, yet only 9 million individuals currently meet this standard. Adding to this issue is the challenge faced by 77% EU companies in recruiting skilled workers, underscoring the urgency of structured and accessible digital skills training that directly addresses industry needs [13].

Advanced digital skills encompass a specialised set of competencies that go beyond basic computer literacy. These skills are typically framed within the domains of technical expertise, information management, communication, collaboration, critical thinking, creativity, and problem solving [8]. To qualify as advanced, such skills often require the integration of progressive technologies, such as Artificial Intelligence (AI), enabling individuals to develop a deeper understanding of digital tools, platforms, and concepts. Consequently, advanced digital skills are frequently characterised by their enabling technologies, which empower users to address complex digital challenges. Professionals with advanced digital skills are increasingly sought after due to their ability to leverage technology for organisational success [2].

> DIGITAL4Business is a transformative EU-funded €20 million project that involves 15 academic, industry, and government partners in seven European countries. It aims to advance digital transformation and training for SMEs and businesses within the EU27, the 27 member states of the EU.

As one of the most significant projects funded by the EU's Digital Europe Programme, DIGITAL4Business seeks to reshape the landscape of advanced digital skills through the delivery of high-quality postgraduate education, including the accredited 60-ECTS-credit joint European *Master's in Advanced Digital Technologies for Business*, microcredentials, and industry-recognised certifications.

The initiative further strengthens collaboration among academic, industry, and government stakeholders to address the growing digital skills gap and foster a sustainable future for digital expertise in Europe.

Specifically, the DIGITAL4Business Master's programme is highly flexible and accessible, catering to a diverse demographic of students with diverse professional backgrounds. To achieve this, the programme employs a modular competency-based structure that allows students to tailor their learning experience to meet their career goals. By integrating academic and industry certifications, the programme provides students with a unique blend of theoretical knowledge and work-ready skills, thus improving their professional profile and employability in the digital marketplace.

A cornerstone of the DIGITAL4Business initiative is its commitment to inclusivity and diversity, prioritising accessible education for students from various socioeconomic and cultural backgrounds. From its inception, DIGITAL4Business has ringfenced budget to fully subsidising tuition fees for under-represented applicants and has assembled a dedicated Equalities, Diversity, and Inclusion Board to implement a comprehensive strategy.

The programme is designed to be affordable and flexible, offering part-time and full-time options and promoting gender equality and ethnic diversity among its cohorts. This approach reflects the broader European goals of fostering inclusive growth and digital equity across member states.

This paper outlines the development and implementation of the DIGITAL4Business Master's curriculum and microcredentials, drawing on insights from a systematic needs analysis conducted with industry stakeholders. The results inform the curriculum's focus on specific digital skills critical to the needs of SMEs and larger enterprises alike. The discussion highlights the methodological approach, curriculum design, and key findings of the programme, culminating in recommendations to further enhance the relevance and effectiveness of the programme. Through ongoing collaboration with industry partners, DIGITAL4Business is poised to play a pivotal role in equipping the European workforce with the skills needed for sustained digital transformation.

2 Related Work

The landscape of digital transformation within the EU has seen considerable evolution over the last two decades, marked by the Digital Agenda for Europe and subsequent frameworks under the EU's 2020 and 2030 Digital Strategies [12]. Initially, the Agenda aimed to increase the accessibility of the Internet and improve digital literacy. By 2020, a shift was observed towards the promotion of high-level digital skills such as AI, cybersecurity, and quantum computing, aligning with the broader EU goals of economic resilience and global technological leadership. These frameworks underscore the urgency of bridging the digital skills gap, with an increasing focus on higher-order competencies required for advanced digital transformation.

Proficiency in advanced digital skills requires a combination of technical expertise, analytical reasoning, domain-specific knowledge, and problem solving capabilities. This underscores the critical importance of promoting collaboration and interdisciplinary education to address skill demands. Furthermore, there is increasing recognition of the ethical and legal dimensions of digital advancements [7], along with the growing importance of lifelong learning, microcredentials, and adaptability to meet the dynamic requirements of contemporary industries [10].

Research on the development of digital skills across Europe highlights several challenges, particularly in the disparity between educational offerings and industry needs, and some countries such as Spain have even identified the heterogeneous nature of skill acquisition due to the regional and provincial location of users [15]. More specifically, it has been documented that Europe is behind the US and the UK in terms of advanced digital skills with some relative weaknesses in the offer of comprehensive training in computer science [14]. Furthermore, a report by the European Centre for the Development of Vocational Training (Cedefop) identified a "disconnect" between educational curricula and the competencies required in rapidly evolving digital sectors [3]. Cedefop emphasises the need for interdisciplinary skills that blend technical proficiency with business acumen and adaptability. This finding is corroborated by studies such as the WEF report "Future of Jobs" [19], which underscores the importance of lifelong learning, modular education, and microcredentials in keeping up with digital advancements.

Organisations, particularly SMEs, that lack professionals with advanced digital competencies often face significant challenges in adopting and effectively implementing technology-intensive projects, which can adversely impact their competitiveness. The literature identifies several key benefits for SMEs that effectively leverage technolo-

gies such as social networks, websites, cloud computing, and data analytics, including improved efficiency and effectiveness, cost savings, improved productivity, higher customer satisfaction, and stronger competitive advantage [11]. Studies focused on SME digitalisation advocate for training programmes that are accessible, affordable, and aligned with SMEs' operational needs. Such programmes would equip employees with practical skills in areas such as cloud computing, data analytics, and cybersecurity, where there is significant unmet demand [1].

Existing educational models for digital skills development offer valuable information, but are arguably not adequate to address the specific needs of mid-level professionals and SMEs [4]. A recent study underscores the critical importance of e-learning and lifelong learning for SMEs to remain competitive in an increasingly digital business environment, as there are significant gaps in employee digital skills with fewer than 55% European SMEs demonstrating adequate digital capabilities [6]. Prioritising e-learning and digital skill development not only addresses existing deficiencies but also positions SMEs to innovate, retain talent, and adapt to rapidly evolving technologies.

Long homogenised under the Bologna agreement, European Master's qualifications are considered essential to supply the high-level skills required by the knowledge economy, attracting students from every part of the world. Joint Master's (a.k.a. multi-institutional) programmes in computing and digital skills have been implemented throughout Europe, such as the European Master's in Software Engineering [9], which incorporates joint curricula and industry placements and on research data management [5]. However, these programmes have often been rigid in structure, focussing on technical knowledge at the expense of industry relevance and practical application. The DIGITAL4Business approach to formal education in advanced digital skills has run an industry-style needs analysis to tailor postgraduate education [17] enabling graduates to match their own skills through a number of elective modules.

Another critical area highlighted in recent research is the ethical and societal implications of digital transformation, particularly in AI and data privacy. The increasing use of AI across industries raises significant ethical concerns, particularly for SMEs. Companies must address the ethical implications of AI on stakeholders, including customers, employees, and society at large, focussing on data privacy, safety, security, and environmental impact. Although larger companies and universities have begun to explore responsible AI practices, SMEs face challenges in adopting these due to a lack of tailored guidelines, training, and accreditation systems [18].

2.1 Contribution

Although significant inroads have been made, there is an increasing need to address barriers preventing SMEs and organisations in general from fostering their employees acquire advanced digital skills with a focus on resource-saving responsible ethical practices. Novel efforts must arguably aim to bridge these gaps through accredited curricula with adequate flexible training tools. DIGITAL4Business distinguishes itself by providing a market-led curriculum that combines academic and industry certifications, supported by a modular structure conducive to part- and full-time study. This approach enables students to engage with content that is directly applicable to their professional environment, making it particularly suitable for working professionals.

By furnishing a joint European qualification, the DIGITAL4Business Master embraces career mobility with cross-border mobility with recognition of prior experiential learning at the pan-European level. Reliable wide access to the Master's materials is enabled by its intrinsic online nature, which also nurtures critical thinking, problem solving, and teamwork.

> The DIGITAL4Business Master's curricula should be construed as an organic **Education 5.0** [16] programme that intrinsically incorporates advanced digital skills such as AI, cloud computing, data science, and cybersecurity to enable digital transformation through collaborative learning and practical experience. It embraces responsible practices by including modules on data governance, ethics, and digital sustainability, preparing students to navigate complex ethical considerations in their future careers.

3 Method

The design of the curricula first implemented a comprehensive needs analysis using a mixed-method approach, combining extensive desk research with surveys targeting industry experts and professionals. The needs analysis for the DIGITAL4Business project involved a comprehensive review of 292 documents focusing on advanced digital skills across the EU27 countries, supplemented by 24 cross-European studies [5]. This detailed examination aimed to identify skill gaps and emerging needs at the national and regional levels. To enhance the global perspective of the study, 69 additional documents were reviewed covering key international markets such as Australia, Canada, Singapore, the United Kingdom, and the United States. These international sources included government reports, industry publications, academic research, and media articles, providing a holistic view of the demands for advanced digital skills around the world.

The desk research covered a diverse range of document types, including 72 national and 29 European reports that provide information on policy priorities in EU member states. Industry-specific trends were captured through 61 industry publications, revealing the sectoral demand for digital competencies. To ensure academic rigour, 74 scholarly publications were analysed, offering evidence-based perspectives on digital skill development. In addition, 47 related and media articles enriched the study by presenting public discourse and expert opinions. A global context was also achieved through nine key reports from international organisations, such as the World Bank and the OECD, highlighting global trends and challenges in advanced digital skills.

To explore the landscape of digital skills in non-EU contexts such as Australia, Canada, Singapore, the UK, and the US, 69 documents were studied. These included government reports, industry analyses, academic articles, media articles, and other pertinent sources. The general distribution of these reviewed publications is shown in Figure 1.

[5] Due to space constraints, the full list of publications is not included here but is available in an open-access DIGITAL4Business project deliverable from https://digital4business.eu/wp-content/themes/matrixinternet2023/pdf/D2.1-NeedsAnalysisReport.pdf

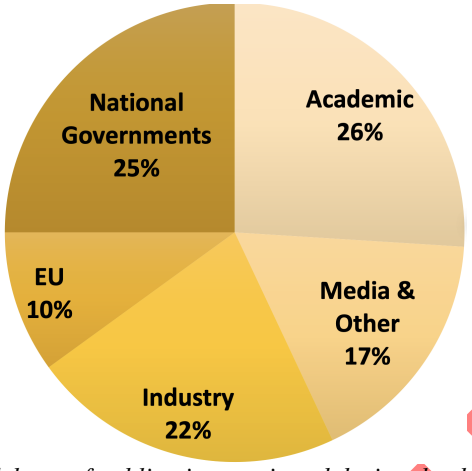

Fig. 1: Breakdown of publications reviewed during the desk research.

Among the reviewed materials, 72 national and 29 European-level reports were identified, providing critical insight into the priorities and requirements for advanced digital skills as outlined by government bodies across the EU27. These reports were essential to understand country-specific needs. In addition, 61 industry reports were reviewed, offering sector-specific perspectives on skill demand. These industry-focused documents highlighted trends and skill sets valued in various sectors of the digital economy.

The academic literature was also key in this analysis. A total of 74 academic publications were examined, contributing evidence-based insights and enriching the understanding of advanced digital skill requirements. In addition, 47 media articles were included to reflect public discourse and sentiment on advanced digital skills, capturing diverse points of view of journalists, commentators, and experts. Finally, nine international reports were reviewed, including documents from global organisations such as the World Bank and the OECD, which provided a broader perspective on digital skills' global demand and gaps.

To address potential biases in the desk research findings, surveys were conducted aimed at representatives of European SMEs and multinational corporations. These surveys were designed to validate the key findings and provide a more balanced and representative perspective. Two approaches were used: i) direct participation in a targeted cohort of industry, academic, and government representatives, and ii) broader outreach through LinkedIn. Respondents were asked to identify critical digital skills required by SMEs and businesses and prioritise advanced digital skills in terms of their importance.

4 Results

The results of the needs analysis underscored the critical role of advanced digital skills in driving business transformation across Europe. The findings indicate that cybersecurity and cloud computing are the most sought-after competencies, especially for SMEs that are increasingly vulnerable to cyber threats and rely on cloud-based solutions. The

curriculum's focus on these areas aligns with market demand, equipping students with the skills necessary to implement secure, scalable digital infrastructures.

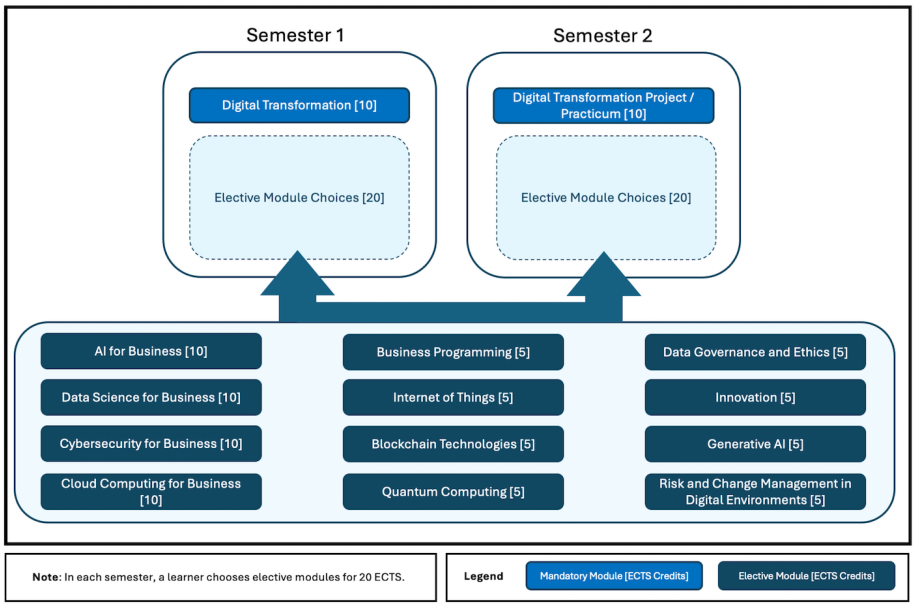

*Fig. 2: The fourteen modules of the 60-ECTS-credit DIGITAL4Business Master's Programme. **N.B.** Only the Digital Transformation and Digital Transformation Project/Practicum modules are mandatory and are complemented by twelve elective modules. The number of ECTS credits is indicated in brackets after each module.*

The DIGITAL4Business Master's curriculum, designed to provide students with a comprehensive training in advanced digital skills, includes fourteen modules, as shown in Figure 2. Each module is crafted to blend theoretical insights with practical applications, ensuring that students acquire competencies that are directly applicable in the industry.

The Master's programme has been further bolstered by the achievement of EQAR (European Quality Assurance Register for Higher Education) accreditation. This recognition validates the quality of the programme and enhances its international credibility. This EQAR accreditation signifies:

- **Recognition Across Europe**: Accreditation based on the European Approach ensures programme acceptance across the European Higher Education Area without additional national criteria, promoting student mobility and career opportunities.
- **Alignment with European Standards**: The programme adheres to the Standards and Guidelines for Quality Assurance in the European Higher Education Area, ensuring transparent and comprehensive quality assurance.

– **Commitment to Quality and Excellence**: The accreditation confirms DIGITAL4Business' commitment to high-quality education aligned with the Qualifications Framework for the European Higher Education Area (QF-EHEA).

	Module ECTs	10 ECTs	10 ECTs	10 ECTs	10 ECTs	10 ECTs	5 ECTs	5 ECTs	5 ECTs	5 ECTs	5 ECTs	5 ECTs	5 ECTs	5 ECTs	
	Role Profile	Digital Transformation	AI 4 Business	Data Science 4 Business	Cloud Computing 4 Business	Cyber security 4 Business	Blockchain 4 Business	IoT 4 Business	Programming 4 Business	Quantum 4 Business	Ethics & Governance	Innovation	Risk & Change Management	Generative AI	Total Credits
1	Procurement Manager	X	X	X	X	X					X		X		60
2	Small Business Owner	X	X	X	X	X					X		X		60
3	HR Professional	X	X	X	X	X					X	X			60
4	Business Operations Manager	X	X	X	X	X					X	X			60
5	Salesperson	X	X	X	X				X		X	X	X		60
6	Junior Software Engineer	X	X	X	X	X			X			X			60
7	Legal Professional	X	X	X	X	X	X				X				60
8	Facilities Management Professional	X	X	X	X	X		X				X			60

Fig. 3: Mapping Master's modules to the role profiles of potential students. ***N.B.*** *The mapping provides an indication and some guidance to learners as to which elective modules may be of greater interest to those who are either in existing roles or who are pursuing attainment of certain roles within organisations; the modules indicated in the mapping table for each of the role profiles are non-restrictive.*

As a Joint Master's degree, there are three leading European higher education institutions, namely National College of Ireland, Università di Bologna, and Universidade Nova de Lisboa, which issue the degree diploma with Linköpings Universitet also collaboratively providing the curricula. That is to say, the fourteen online modules are delivered cohesively by the four institutions with three collaboratively signing the diploma degree at European level.

4.1 Employability

As part of Master's programme development, several intended competency profiles for learners were considered as being representative of general business roles that will need to develop advanced digital skills as digital transformation continues to evolve across organisations, from SMEs to multinational corporations.

Learners may typically indicate a preference to enrol in elective modules that have been identified with particular role profiles, as shown in Figure 3. Each of these roles plays a crucial role in the overall functioning of an organisation, and their adaptation to advanced digital skills is essential for the development of the career of learners and the success of their organisations. Namely:

– Procurement managers need to embrace digital tools for efficient vendor management and cost optimisation.
– Small Business Owners must adapt to digital marketing, e-commerce, and financial technologies to remain competitive.

- HR professionals are tasked with managing digital talent acquisition and employee engagement tools.
- Business Operations Managers require digital analytics and process optimisation skills.
- Salespeople benefit from customer relationship management software and online sales platforms.
- Junior Software Engineers must keep up with rapidly evolving programming languages and technologies.
- Legal professionals need to understand digital compliance and intellectual property laws in the digital era.
- Facilities management professionals can take advantage of the Internet of Things (IoT) and smart building technologies.

Similarly, Supply Chain Management Professionals must navigate complex digital supply chains and logistics. While SMEs' engineers must integrate digital design and manufacturing processes, SMEs Office Administrators should use digital tools for efficient office management. Finance professionals need advanced data analysis and financial software skills. Similarly, Product managers rely on digital product development and market analysis tools, while Marketing professionals require digital marketing strategies and data analytics. Project managers benefit from project management software and collaboration tools. Finally, Customer Services Professionals must use digital communication and support platforms to meet customer expectations.

Although the above set of occupational profiles is not comprehensive, it provides a career planning tool for students to choose their modules within the DIGITAL4Business Master's programme or simply undertake a microcredential that is associated with the 10 ECTS modules. In this rapidly evolving digital landscape, the above roles encompass a wide spectrum of business operations, making them integral in the digital transformation journey for organisations of all sizes.

Each role has been assessed and the most relevant advanced digital skills modules have been chosen to prepare learners for their specific career needs. The aim is to help learners choose the right modules tailored to their discipline. Once a learner completes the mandatory Digital Transformation module, they can select from a suite of elective modules that align with their interests. The mapping of modules to a set of sample roles serves as a guide for learners as they progress through their study programme.

> Following a pilot in Summer 2024, the Master's programme officially started in November 2024 and its initial cohort is currently undertaking the *Digital Transformation* module taught by Università di Bologna.

4.2 Platform

Offered online, the joint Master's degree is backed up by a dedicated cloud-based platform that includes a Moodle-based portal with Leaning Management System (shown in Figure 4) and a Full Fabric back-end to handle all student services from application to graduation. It has interfaces to payment systems and applications to handle efficient

multimedia delivery (e.g. Vimeo), code repositories (e.g. GitHub) as well as connections to distinct library systems.

Underpinned by the platform, lectures are given asynchronously and complemented by laboratories and tutorials demonstrated synchronously. While the full Master's programme is to be undertaken online by learners across Europe, it is also envisioned that there will be some optional face-to-face networking activities organised in different countries by industry partners.

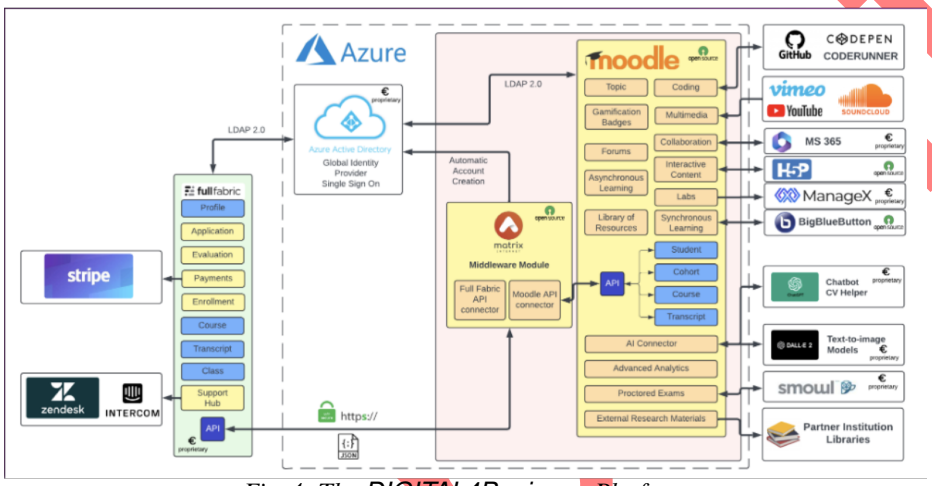

Fig. 4: The DIGITAL4Business Platform

5 Recommendations

Based on the findings, several recommendations are proposed to optimise the impact of DIGITAL4Business. First, it is recommended to maintain regular curriculum updates to reflect emerging trends in digital technology, ensuring that graduates remain competitive in the job market. This could involve annual reviews and the addition of new modules in areas such as quantum computing, augmented reality, and edge computing as these technologies mature.

In addition, there is a need to strengthen partnerships with SMEs, allowing more custom curriculum adjustments that reflect the evolving needs of smaller businesses. This partnership model could include regular feedback loops with industry representatives and SME-focused workshops to co-develop new learning resources and case studies.

The programme could also benefit from expanded language support to increase accessibility throughout Europe. Although English is the main language of instruction, offering modules in other languages of the EU, particularly German, French, and Spanish, could expand the reach of the programme and facilitate greater inclusion.

Another recommendation is to improve the practical and hands-on elements of the curriculum. Although current modules incorporate work-based learning and real-world

case studies, expanding these components to include more industry projects and virtual laboratories could provide students with deeper experiential learning opportunities.

Although the above recommendations have been derived from the initial DIGITAL4Business Needs Analysis [17], they will be improved over tie by incorporating the lessons learnt from the Master's graduates and teaching staff.

6 Conclusion

DIGITAL4Business represents a strategic initiative aimed at transforming Europe's digital skills landscape. By delivering a modular Master's programme aligned with industry, the project addresses the urgent demand for digital skills that are critical to the competitiveness and resilience of European businesses. The findings of the needs analysis, which highlight the importance of cybersecurity, AI, cloud computing, and data science, provide a solid foundation for curriculum design. This ensures that graduates possess the competencies necessary to drive digital innovation in all sectors.

As the project progresses, ongoing collaboration with industry partners will be crucial to maintaining the relevance and adaptability of the curriculum. The recommendations presented underscore the need for flexibility and responsiveness to emerging trends, suggesting a dynamic curriculum that can evolve with technological advances. DIGITAL4Business thus stands as a model for inclusive and market-driven digital education that supports Europe's broader goals of digital transformation and economic recovery. Through continued innovation and strategic partnerships, the project has the potential to have a lasting impact on Europe's digital workforce and contribute to a more inclusive and digitally skilled society.

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