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# **Tertiarization & sustainability new challenges for management in the digital era**

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# **Tertiarization & sustainability. New challenges for management in the digital era**

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edited by

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# The Future of Education: reframing skills and learning in the age of artificial intelligence

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## Abstract

*The introduction of artificial intelligence (AI) into education is fundamentally transforming learning models, skill requirements, and labor market dynamics. This study explores how AI adoption is reshaping education, focusing on the skills needed to address AI-driven changes. Through interviews with CEOs and educational experts, the research highlights the challenges and opportunities in both educational and professional contexts, emphasizing the importance of balancing hard and soft skills and promoting continuous learning. Using co-occurrence analysis with T-Lab software, the study uncovers how AI is altering learning models, data management, professional training, and cross-sector partnerships. The findings provide practical insights for educational institutions and businesses to better align curricula and learning approaches with emerging market demands, thereby supporting the workforce's adaptive capacities.*

**Introduction and background.** *In an increasingly digitalized world, technology has moved beyond being merely a support tool or enhancer, becoming an infrastructural layer that permeates society and profoundly influences both the labor market and education. Digital technologies have established themselves as enabling factors across various sectors, including education, leading to a growing reliance on their applications by both users and institutions (Rahmatullah et al., 2022). Today, with digital technologies integrated into living spaces, students are digital natives and have grown accustomed to engaging with active and interactive learning methods, which they find more effective than traditional, passive approaches (Kozanitis & Nenciovici, 2023). On the other hand, the workforce is increasingly composed of an aging population, which necessitates ongoing training and the development of new educational models that cater to the need for lifelong learning. These combined pressures have led to a shift in the role of technology in education, making it not just an optional enhancement but a critical element for addressing the diverse needs and expectations of both younger and older generations in today's workforce (Hashim, 2018).*

*In this evolving landscape, artificial intelligence has emerged as a key driver of transformation, with recent technological advancements and the growing proliferation of AI pushing the discussion beyond theoretical speculation toward empirical research focused on its tangible impact on learning processes and teaching methodologies (Kaplan & Haenlein, 2019; Labadze et al., 2023). This shift is already visible in concrete applications that are reshaping learning models and the overall educational experience, making it more adaptive, interactive, and tailored to students' needs.*

*According to a recent Microsoft report (2024), in school settings, 95% of institutional leaders, 68% of educators, and 62% of students report engaging with AI-powered tools in some capacity, highlighting the growing integration of these technologies into everyday teaching and learning practices. Institutional leaders primarily leverage AI to enhance the efficiency of operational and administrative processes (37%) and to improve equitable access to educational knowledge and resources (34%) (source). Educators integrate AI into their lesson planning workflows and the management of supporting materials and assignments (24%), while also utilizing it to simplify complex topics for students (20%). Meanwhile, students report using AI for summarizing information (35%) and for brainstorming and generating initial ideas for assignments (32%).*

*These trends show how AI is being seamlessly incorporated at multiple levels of the educational ecosystem: rather than serving as a mere tool for automation, AI functions as a support mechanism that augments human capabilities, streamlining routine tasks while enabling educators and students to focus on more cognitively demanding and creative aspects of learning and teaching.*

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Research shows that a key application of AI in education is the use of chatbots, which engage students in dynamic interactions, fostering sustained dialogue and enhancing engagement with the subject matter (Perez et al., 2020). Likewise, expert systems are increasingly employed for pedagogical planning, supporting educators in the development of more efficient and personalized curricula (Huang et al., 2021). AI also plays a critical role in shaping the relational dimensions of education—for instance, Learning Management Systems (LMS) optimize interactions between students and instructors, facilitating a more collaborative and continuous learning experience (Dias et al., 2015). More broadly, AI-driven predictive models enable proactive and adaptive learning strategies, fostering a more equitable educational framework by dynamically adjusting to individual learning needs and cognitive styles.

At the same time, AI is reshaping how educational institutions approach learning and management. It goes beyond automating tasks and streamlining processes, driving a fundamental change in how people learn, collaborate, and make decisions. Through AI integration, organizations are not just improving existing methods but are fundamentally transforming how knowledge is created, shared, and applied. For instance, AI enhances organizational learning by facilitating iterative co-creation, where knowledge is continuously assimilated and reused (Massa et al., 2023). Building on Simon's (1991) concept of bounded rationality, AI helps overcome human limitations in decision-making, offering predictive models and decision-support tools. One of AI's most powerful contributions is to experiential learning, where individuals engage with smart tools, access new information, and receive immediate feedback, all while learning through simulation and modeling. This approach fosters proactive learning by allowing students to explore different solutions in virtual scenarios before applying them in the real world. AI also nurtures incremental learning, enhancing processes and improving efficiency over time by providing real-time feedback and allowing continuous refinement of skills and knowledge.

The impact of AI influences not only educational frameworks (Xue et al., 2022) but also leads to a shift in the skills required by employers and, consequently, in those that educational institutions must develop to address this mismatch (An et al., 2024).

In the context of AI, the balance between hard and soft skills is particularly significant. While effective use of AI requires hard skills such as data analysis, prompt engineering, and overall data literacy, soft skills play an equally critical role. Competencies such as curiosity, problem-solving, lateral thinking, and adaptability enable individuals to respond to market changes and adopt a continuous learning approach (Pustalova & Vahter, 2025). Useful in this regard is the concept of complementarity between human and artificial intelligences, based on the idea that, although artificial intelligence (AI) can take on specific tasks with efficiency and precision, human qualities such as creativity, empathy, and critical thinking remain indispensable in many contexts. With this in mind, a vision of learning models is developing in which AI does not merely replace human work but enhances it by promoting synergistic collaboration between humans and machines (Brynjolfsson & McAfee, 2017).

The adoption of AI in education presents challenges, particularly the risk of reducing critical and creative thinking. Ethical concerns, such as data protection, require clear regulatory frameworks and ethical guidelines. A "Human by Design" approach is essential, ensuring individuals remain central to technological development. Educational institutions, especially universities, must guide innovation and support the transition to hybrid roles involving AI. AI integration should also involve humanities subjects to foster a critical approach, addressing both technological and ethical issues, ensuring equitable access to learning, and maintaining academic integrity.

**Purpose of the paper.** Despite the growing body of literature on AI in education, there is limited empirical research on how educational institutions and businesses perceive the changing skill requirements. This study addresses this gap by comparing insights from CEOs and education experts on the evolving interplay between AI, skills development, and professional training. In light of these transformations, it is essential to understand how education is evolving to meet the skill needs that arise from the rapid integration of disruptive technologies in business.

Hence, our research, currently in progress, aims to deepen the understanding of how artificial intelligence is reshaping the skills required by the labor market and how educational institutions, businesses, and governments are responding to these needs in the world of work.

**Methodology.** The research is based on 19 in-depth interviews conducted between October 2024 and March 2025 with 15 CEOs and Presidents from Italian companies across sectors such as IT, consultancy, fashion, finance, shipbuilding, steel, and aviation, alongside 4 education experts. The sample, selected through a key informant approach (Robson & Foster, 1989), included both public and private organizations and aimed to capture strategic perspectives on the intersection between AI, education, and work transformation. Interviews followed a loosely structured protocol exploring AI's impact at macro (society and economy), meso (organizational models), and micro (skills and learning needs) levels. Each conversation lasted about an hour and was recorded, transcribed with AI tools, and anonymized. Data analysis combined text mining with qualitative interpretation. Using T-LAB software (Lancia, 2012), we examined keyword frequencies and co-occurrences, producing ego networks and word clouds to highlight emerging themes. This was integrated with cognitive mapping (Eden, 2004), which traced cause-effect links among concepts in each interview, later merged into a collective map of shared perceptions, visualized via Mural.

**Results.** The following section presents the findings of our study, structured to first illustrate the perspectives of the two panels: Education Experts and CEOs. This division allows for a clearer understanding of how AI is perceived in terms of its impact on skills development and education from both a corporate and an academic standpoint.

After presenting these viewpoints separately, the analysis highlights areas of convergence and divergence between the two groups. This comparative approach helps to identify common ground in addressing the challenges posed by AI, as well as the differing priorities and concerns that emerge within each professional domain.

a) *Education Panel*

The interviews reveal a strong focus on developing the skills necessary to face the challenges of AI in the labor market. In particular, the keyword analysis suggests the extent of change resulting from AI integration in education, affecting both higher and continuing education as well as labor market dynamics.

The most recurrent terms include “artificial intelligence”, alongside “individual”, “skills” (including “soft skills”), “university”, “young people”, “work”, and “training paths.” This highlights the central role of AI as a technological phenomenon with a profound impact on competencies, the pivotal function of universities, and the future of educational pathways in relation to ongoing technological advancements.

Additionally, the prominence of terms such as “learning processes” and “proper use” underlines the interviewees’ focus on how AI is integrated into educational programs. This suggests that experts are not only concerned with the methodological aspects of AI-driven learning but also with the ethical implications of using AI in education.

The topic of skills also emerges as highly relevant. A strong emphasis is placed on the development of soft skills, particularly analytical thinking in relation to AI (comprehension skills). This suggests that, beyond technical knowledge, interviewees consider transversal skills to be crucial, necessitating the development of new hybrid approaches to skills training in the context of AI.

At the same time, the high recurrence of terms such as “enterprise”, “European alliances”, and “university” highlights the importance of adopting a shared vision and fostering cooperative approaches among various stakeholders. These collaborations are not limited to academia but also involve the corporate sector. Accordingly, priority is given to creating collaborative models between universities and businesses that transcend national boundaries. This aims to address the challenges related to designing learning models in the new scenarios shaped by AI adoption in educational contexts, following open and multilateral approaches.

Furthermore, the network analysis enabled the classification of interview narratives into five main semantic categories:

1. *Technology and human-machine interaction.* This category centers on the interaction between machines and individuals, with a particular focus on the responsible use of technology. Education and institutional roles serve as key levers of change. The “individual” node introduces the theme of multidisciplinary education, which is essential for managing the human-machine relationship. Keywords such as “philosophical subjects” and “digital skills” further indicate the need to bridge the gap between humanities and STEM disciplines, fostering synergies across fields to equip individuals with the skills required for effective AI interaction.
2. *AI as a global and local phenomenon.* This category positions AI as a transformative technological force in education, capable of reshaping the role of universities within society and learning environments. The analysis underscores the need to strengthen connections between universities and schools, as well as between the educational and economic sectors. Universities emerge as the primary drivers of skills development among young people, with a strong emphasis on aligning academic degrees with the requirements of new professions.
3. *Training models.* This category focuses on educational models, particularly the structuring of study programs and the modularity and flexibility of their design (e.g., elective courses offered in a modular format). AI is perceived as a challenge, as indicated by the strong association between the terms “training models” and “challenge.” This challenge encompasses both learning processes and skill development, particularly soft skills.
4. *Skills development.* This category revolves around the concepts of competencies and professions, highlighting keywords such as “skills acquisition”, “learning processes”, and their connection to the labor market. The analysis suggests that continuous training is a crucial tool for updating skills and aligning professional profiles with market needs.
5. *International collaborations.* Another key category relates to international partnerships, emphasizing the importance of European alliances and the globalization of training institutions. Education experts consider these collaborations to be critical for tackling AI-related challenges, both in terms of educational practices and the evolution of professional roles.

b) *CEOs Panel*

The CEOs’ narratives revolve around four key terms—technology, work, data management, and corporate organization—in addition to the overarching theme of artificial intelligence.

The term “technology” suggests the role of AI as a central driver of transformation, affecting data management, corporate structures, and innovation processes within both economic and societal frameworks. AI is perceived not only as an economic tool but also as a social phenomenon, as indicated by the prominence of keywords like “culture” and “human being.”

*The systematic analysis of these terms reveals a strong emphasis on the need for a responsible and conscious adoption of AI. This perspective highlights the importance of fostering trust and an open corporate culture, promoting ethical AI use, and ensuring that technological advancements are fully integrated into human-centered business environments.*

*Additionally, the frequent mention of “work”, “skills”, “individual”, and “training” underscores CEOs’ recognition of AI’s impact on labor dynamics. This transformation extends beyond automation, encompassing skill development, workforce adaptation, and the creation of new professional roles.*

*The CEOs’ discourse is structured around three focal areas, each analyzed through ego network mapping: business models, competencies, and processes. These clusters reflect how AI is shaping corporate strategy, workforce skills, and organizational decision-making.*

- 1. Business Models. AI is seen as a transformative force reshaping business models by redefining value creation mechanisms. Key areas of impact include resources, data, and core activities, which drive the development of AI-powered products and services. A particularly strong association emerges between business models and data management, highlighting how AI enhances strategic decision-making through predictive analytics and competitive insights. This data-driven approach strengthens companies’ adaptability in dynamic markets, fostering flexibility, innovation, and business growth.*
- 2. Competencies. AI is fundamentally altering the landscape of required workforce competencies, expanding beyond technical expertise to encompass managerial and strategic skills. While AI-related technical skills (e.g., machine learning, information technology, and language models) remain crucial, CEOs emphasize the growing importance of strategic thinking and competitive analysis. Additionally, soft skills such as adaptability and continuous learning emerge as key factors in navigating AI-driven transformation. The strong link between competencies, training, and work in the ego network underscores the urgency of upskilling and reskilling initiatives. AI is accelerating the need for educational programs that align with evolving job market demands, reinforcing the creation of new professional roles.*
- 3. Processes. AI is redefining corporate processes, particularly in decision-making and data-driven management. The CEOs’ discourse highlights how AI-powered predictive analytics and data management support more informed, agile, and proactive decision-making models. This shift reflects AI’s role as a strategic enabler, not merely an automation tool, enhancing organizational responsiveness and efficiency. The increasing reliance on AI for adaptive decision-making further underscores its integration into the core functions of modern enterprises.*

#### *Comparative analysis: alignments and tensions in AI-driven transformation*

*The interviews with CEOs and education experts provide valuable insights into the AI-driven transformation of education and its spillover effects on skills and the labor market. The findings presented highlight both areas of alignment and divergence in how AI is reshaping competencies, learning models, and the workforce.*

*A key point of convergence is the recognition of AI not merely as a support tool but as a transformative force influencing both business strategy and education systems. Both panels emphasize the need for continuous skills development to adapt to AI-driven shifts in the labor market. While both groups acknowledge the importance of lifelong learning as a response to these changes, CEOs focus on AI’s role in enhancing strategic decision-making and business efficiency, particularly in terms of skill demands and emerging professional roles. In contrast, training experts stress the need for educational programs that integrate technical, managerial, and transversal skills to adequately prepare individuals for these evolving roles. Similarly, both groups recognize the central role of universities in bridging the gap between academia and industry. There is a shared emphasis on strengthening the dialogue between educational institutions and businesses to improve the alignment between labor supply and demand, fostering new opportunities in an AI-transformed job market.*

*Among the areas of divergence, on the contrary, significant dissonances in priorities and approaches emerge. While CEOs focus on AI as a driver of competitiveness and productivity, mostly viewing its impact through the lens of business models, operational efficiency and decision-making processes, and prioritizing data-driven strategies, predictive analytics and automation as key enablers of business growth, on the contrary, education experts take a broader and more systemic view, emphasizing the ethical, cognitive and social dimensions of AI adoption. Their more holistic vision reflects concerns about the responsible use of AI, human-centered learning models and the integration of multidisciplinary approaches, especially the need to balance STEM and humanities education.*

*These differences reveal an underlying tension between short-term efficiency and long-term adaptability, two contrasting but parallel needs. Short-term efficiency is mostly sought by CEOs in immediate AI-driven benefits for organizational performance, while long-term benefits are preferred by the panel of education experts through a sustainable and inclusive learning framework that fosters critical thinking and ethical awareness along with technological expertise. To address this gap and seize both short-term and long-term opportunities, coordinated efforts are needed to align business needs with education policies, ensuring that AI adoption leads to both economic innovation and social responsibility.*

*This comparative analysis therefore highlights the keystone to resolve such tensions in cross-sectoral dialogue and strategic cooperation between business and education, to manage AI-driven transformation with both technical and human-centric skills.*

**Research limitations.** *The study, still in progress, presents the preliminary results of the first 20 interviews. This limited sample size imposes obvious constraints on the generalizability of the findings, which may not fully represent the views and experiences of a broader population. Additionally, the sample was selected using a non-probability sampling method, which could introduce bias in terms of representativeness. The inclusion of CEOs from large companies and experts in higher education may limit the diversity of perspectives. Further development of this study could address this limitation by employing a quota sampling approach to ensure a more balanced representation across different sectors and organizational levels.*

**Managerial implications.** *This research provides managerial implications for both businesses and educational institutions. For companies, it emphasizes the importance of designing continuous training programs focused on micro-competencies to bridge the skill gaps emerging from the disconnect between traditional, linear training programs and the rapidly evolving technological landscape.*

*Companies investing in AI integration can achieve significant benefits in operational efficiency, productivity, and revenue growth. However, these results depend not only on the technology itself but on how it is adopted-by fostering collaboration between human and artificial intelligence and creating a culture of learning, collaboration, and innovation. Businesses should integrate both hard and soft skills development, ensuring that employees are equipped not only with technical knowledge but also with critical thinking, creativity, and adaptability, which are essential in today's rapidly changing environment.*

*For educational institutions, the recommendation is to adapt curricula to be more dynamic and aligned with industry demands, encouraging lifelong learning practices that reflect the ongoing need for skills updating. Educators will play a key role as learning designers, helping students develop personalized, interdisciplinary competencies connected to real-world challenges. AI can assist in innovating curricula, automating routine tasks, and creating learning resources, enabling educators to focus on high-value activities such as mentorship and designing engaging, interactive learning experiences. Both sectors are urged to enhance collaboration to address the challenges posed by disruptive technologies, ensuring that education and training evolve in tandem with these changes.*

**Originality of the paper.** *Our work stands out by offering a unique perspective that compares both managerial and academic viewpoints. This dual approach provides a comprehensive and systemic understanding of the impacts of AI on education and workforce development. By proposing a comparative framework that bridges the emerging skill gaps in both corporate and academic environments, our research offers a practical solution for adapting education and training to today's dynamic technological landscape, distinguishing our work as an innovative contribution to the field. The paper contributes to current debates in the fields of innovation management and education strategy by framing AI not only as a technological shift but as a socio-organizational transformation that requires rethinking the design of learning systems, both within firms and educational institutions. AI's transformative potential in education necessitates a balanced approach to skills development, integrating technical, managerial, and soft skills. This multidimensional focus enhances the existing literature on workforce reskilling and lifelong learning in AI-driven contexts.*

*By fostering dialogue between academia and industry, educational institutions can better align curricula with evolving market needs. In doing so, the study addresses a gap in the literature by offering empirical insights into how different actors, managers and educators, are interpreting and reacting to AI, and what this means for the future of human capital development. The study's comparative analysis highlights the importance of integrating ethical considerations with technical advancements, promoting a holistic and adaptive educational paradigm.*

**Key words:** *artificial intelligence; education; AIed; skills; lifelong learning; educational reform*

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