e-mentor
DWUMIESIĘCZNIK SZKOŁY GŁÓWNEJ HANDLOWEJ W WARSZAWIE
WSPÓŁWYDAWCA: FUNDACJA PROMOCJI I AKREDYTACJ KIERUNKÓW EKONOMICZNYCH

2025, nr 4 (111)

Skrzymowska, A. M. (2025). Upskilling and reskilling in the AI era: a new logic of competence development. *e-mentor, 4*(111), 70–78. https://www.doi.org/10.15219/em111.1721

Agnieszka Marta Skrzymowska

Upskilling and Reskilling in the AI Era: A New Logic of Competence Development

Abstract

Generative artificial intelligence (GenAI) is reshaping professional education, hastening the obsolescence of competences and unsettling traditional, linear approaches to upskilling and reskilling. This article advances a new logic of competence development to characterise this shift. Drawing on institutional reports (DeVry University, 2024; World Economic Forum, 2023, 2025) and established theoretical traditions, it shows that the competence landscape is moving towards hybrid models that combine technical expertise with adaptive capabilities such as resilience, reflective judgement and AI literacy. A comparative analysis of employers' and employees' perspectives reveals both opportunities and risks, notably gaps in recognition, digital inequalities and a shifting of responsibility for learning. Using the gAI-PT4I4 prototype as an illustrative case, the article demonstrates how GenAI can serve as a vehicle for adaptive, personalised learning and training, while raising questions about scalability, ethics and deskilling. The conceptual contribution is to define competence development as an iterative, co-created and adaptive process, in contrast to static, competence-based models. At the same time, AI can itself provide a pathway for developing new competences, supporting the complex processes of upskilling and reskilling. The gAI-PT4I4 case connects the conceptual argument to a concrete example of AI-enabled adaptive learning.

Keywords: reskilling, upskilling, competence development, capability approach, generative artificial intelligence

Introduction

The release of ChatGPT in November 2022 marked a turning point in the worldwide diffusion of large language models (LLMs) as a transformative form of artificial intelligence. Within weeks, it had attracted more than 100 million users, making LLMs the fastest-adopted technology in history and reshaping approaches to learning, work and competence development. Unlike earlier waves of digital transformation, which were predominantly institution led (Brynjolfsson & McAfee, 2014), GenAI has diffused more democratically, lowering barriers to access and fostering more personalised learning.

From a labour market perspective, competences are increasingly regarded as strategic assets, consistent with the resource-based view in management studies (Barney, 1991). The challenge, however, lies less in foreseeing which competences will matter than in acquiring them quickly and effectively, as their life cycles grow ever shorter. Traditional, linear approaches cannot keep pace with this acceleration. Whilst fears of job displacement dominate public debate, recent studies paint a more nuanced picture: GenAI complements human capacities such as reasoning, creativity and problem solving (Noy & Zhang, 2023). The ability to collaborate with AI, whilst retaining judgement and ethical responsibility, is fast becoming a defining competence for the future of work.

At the same time, GenAI is a disruptive force, destabilising competence frameworks, career paths and education systems. Existing validation mechanisms, such as diplomas and occupational classifications, often fail to recognise competences acquired informally, thereby reinforcing inequalities of opportunity. Addressing these challenges demands not only technological solutions but also conceptual and institutional reform.

International reports, including the *Future of Jobs* (2023, 2025) and DeVry University's *Closing the Gap* (2024), offer valuable forecasts and underscore the role of employers

Agnieszka Marta Skrzymowska, Independent Researcher, Poland, https://orcid.org/0009-0002-7884-0491

in upskilling and reskilling. Yet their vantage point is often one-sided, privileging the cataloguing of skills over analysis of the qualitative transformation of competence development. Academic debate shows similar limitations, frequently overlooking the systemic implications of AI-driven change. Consequently, the discourse is dominated by lists of skills and roles, laying bare the inadequacy of traditional validation systems.

The research gap is clear: although future competences have been widely identified and are intuitively recognised as qualitatively different, this awareness has not yet translated into substantive change in upskilling and reskilling programmes. The pressing task is to design pathways that are not only effective but also agile and adaptive, capable of keeping pace with the next wave of change already on the horizon.

This paper advances the notion of a new logic of competence development to capture the qualitative shift in how competences are created, validated and sustained in the AI era. In contrast with the traditional linear model, this new logic is iterative, distributed and relational. It treats competences not as static assets but as dynamic capabilities co-shaped through continuous interaction with intelligent technologies. This perspective foregrounds adaptability, critical judgement and ethical responsibility, whilst recognising AI as an active partner in the learning process.

The paper combines the stability of competence-based approaches with the flexibility of capability-oriented perspectives (Kolb, 1984; Nonaka & Takeuchi, 1995; Schön, 1992) and emphasises the enabling role of AI technologies. The argument proceeds on two levels: conceptually, by clarifying this shift; and illustratively, through the gAI-PT4I4 prototype. The prototype serves as an empirical anchor for the proposed logic of competence development rather than a mere technological illustration. It shows how AI-enabled learning can foster adaptive, co-creative competence building. For analytical clarity, the paper adopts the definition of competence used in the European Qualifications Framework (EQF): 'Competence means the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development' (Council of the European Union, 2017). The analysis is confined to the professional context, with particular focus on upskilling and reskilling in workplace settings.

The article is structured as follows. The first section outlines the competence landscape in the AI era, followed by a review of key theoretical approaches. The next section analyses the *Future of Jobs* surveys, examining changes in the qualities and rankings of competences, evolving perceptions of AI, acquisition pathways and the shifting logic of upskilling and reskilling, and concludes by drawing out systemic implications. The subsequent section introduces the employee perspective based on the DeVry survey. An illustrative case of AI-supported learning via the gAI-PT4I4 prototype then follows. The paper ends with conclusions that synthesise these insights into a new logic of competence development and identify directions for future research.

Methodology

This study adopts a conceptual design grounded in secondary sources and reflective analysis. It draws on institutional reports treated as grey literature with demonstrable influence on labour and education policy. Source selection was guided by three criteria: large-scale employer surveys, direct relevance to competence development and evidence of policy uptake. On this basis, two datasets were selected: the World Economic Forum's reports (2023 and 2025 editions) and DeVry University's *Closing the Gap* (2024).

The primary focus was the WEF reports, examined through a comparative analysis of the two editions and the systematic coding of competences. Each skill constituted a unit of analysis: every identified competence was recorded as a single entry and assigned an orientation. Coding was undertaken by a single researcher to ensure consistency, but this also constitutes a methodological limitation, as inter-coder reliability could not be assessed.

The coding scheme was organised around three dimensions: orientation, acquisition pathway and learning context. The reports themselves do not explicitly classify competences by competence- or capability-based orientations. This distinction reflects an analytical lens introduced by the study rather than an explicit feature of the data. The orientation dimension was therefore coded latently, guided by the theoretical framing rather than by labels used in the reports. Such an interpretive approach inevitably entails a degree of theory led categorisation; however, this is consistent with qualitative research practice, provided it is made explicit. Table 1 presents the coding scheme.

In addition, the reports were analysed at the textual level, with particular attention to framing and shifts in language.

This made it possible to trace not only changes in rankings but also the underlying patterns of transformation. For triangulation, the DeVry University study was included to highlight differences between employer and employee perspectives.

The guiding research question was: *How do competence- and capability-based framings emerge in institutional reports, and what are their implications for upskilling and reskilling?*

The conceptual framing drew on established perspectives: experiential learning (Kolb, 1984), reflective practice (Schön, 1992), knowledge creation (Nonaka & Takeuchi, 1995) and capability theory (Nussbaum, 2011; Sen, 1999). The gAI-PT4I4 prototype is presented as an illustrative example of AI-supported competence development. Given its limited empirical validation ($n = 20$, no control group, short term scope), it should be read as an exploratory demonstration rather than conclusive evidence.

Table 1
Codebook for Skills Outlook (WEF 2023 & 2025)

	Code	Operational definition (anchored in WEF language)	Inclusion / Exclusion rules	Example terms / phrases
Orientation	Competence-based	Frames workforce needs in terms of discrete, measurable skills (e.g., core skills, skills gaps, skills disruption); emphasis on possession of competences.	Include when text lists specific skills. Exclude when adaptability is emphasised.	core skills; skills gaps; skills disruption
	Capability-based	Emphasises adaptive potential, resilience, and lifelong learning. Focus on becoming and adapting.	Include resilience, adaptability, continuous learning. Exclude fixed technical lists.	resilience, flexibility and agility; curiosity and lifelong learning; lifelong learning as the lifecycle of skills decreases
Acquisition Pathways	Formal education	Universities, schools, structured qualifications.	Include 'higher education teachers', 'education systems'. Exclude short courses.	higher education teachers; public education systems
	Workplace training	Employer-led learning: on-the-job training, apprenticeships, coaching.	Include 'on-the-job training', 'apprenticeships'. Exclude self-learning.	on-the-job training and coaching; employer-sponsored apprenticeships
	Micro-credentials	Short, modular certifications or digital courses.	Include 'short courses', 'certifications'. Exclude full degrees.	short courses; certifications
	Experiential / / project learning	Learning through project work, rotations, applied practice.	Include 'project-based learning', 'job rotation'.	project-based learning; job rotation
	Communities & peer learning	Mentoring, peer-to-peer networks, communities of practice.	Include 'peer learning', 'mentorship'. Exclude formal education.	peer learning; mentorship
	AI-enabled / / adaptive learning	Technology- and AI-driven personalised training.	Include AI-driven platforms, GenAI training.	Generative AI training; adaptive learning platforms
Learning Context	Individual	Self-learning, personal initiative to build skills.	Include 'self-learning', 'individual learners'.	individual learners focused on GenAI skills
	Team	Collaborative learning within small groups.	Include 'team upskilling', 'collaborative learning'.	team upskilling; collaborative learning
	Organisational	Company-wide workforce development strategies.	Include 'corporate training initiatives', 'workforce strategies'.	upskilling their workforce; organisations identify skills gaps
	Ecosystemic	Sector-wide, regional, or policy-driven approaches.	Include 'public policies', 'Reskilling Revolution'.	funding for reskilling and upskilling; Reskilling Revolution

Source: author's own work.

This study also acknowledges several limitations: reliance on grey literature, the absence of primary data triangulation, a single-coder design for the coding process, and the interpretive nature of the analysis, shaped not only by the data but also by the researcher's perspective. Nevertheless, the methodology offers a transparent and replicable framework for examining transformations in competence development in the AI era.

The Competence Landscape in the AI Era

Any considered reflection on the future of competences benefits from a brief survey of the models that have shaped their definition and development in recent decades. In Europe, debate has been strongly influenced by the Bologna Process and by instruments such as the European Qualifications Framework (EQF) and ESCO (European Skills, Competences,

Qualifications and Occupations), which together have institutionalised a competence-based approach. This model emphasises measurable, observable skills mapped to defined proficiency levels, thereby supporting standardisation and comparability across education systems and labour markets. A similar philosophy underpins the Skills Framework for the Information Age (SFIA), widely applied in the IT sector. Increasingly, however, this competence-oriented view is being challenged by a capability-based approach, which highlights foregrounds adaptability, problem solving and reflective practice in volatile, uncertain environments.

The accelerating digital transformation and the spread of artificial intelligence are reshaping the very foundations of competence development. The rapid diffusion of generative AI has both heightened the salience of competences as strategic resources whilst exposing the limitations of traditional, static frameworks. Competence development can no longer be conceived as a linear process of skill accumulation; it must be understood as a dynamic interplay between stability and adaptability.

These debates crystallise into two dominant perspectives. The competence-based approach conceives competences as measurable sets of skills, knowledge and behaviours required to perform specific tasks. It underpins most international reports and labour market policies because it enables standardisation, benchmarking and comparability across sectors. By contrast, the capability-based approach emphasises adaptability, reflective practice and the ability to navigate uncertainty. Capabilities are not reducible to discrete skills; rather, they denote the capacity to integrate knowledge, exercise judgement and co-create solutions in evolving contexts.

The coexistence of these approaches reveals a structural tension in competence development. On the one hand, employers and policymakers seek frameworks that deliver measurable outputs and facilitate certification. On the other, the volatility of the AI era exposes the limits of such frameworks and highlights the need for competences that cannot be pre-defined in catalogues but emerge dynamically through practice. In this light, competences and capabilities are better seen as complementary dimensions: competence-based approaches supply stability and structure, while capability-based approaches confer adaptability and resilience.

The advent of AI reinforces this dual logic. Generative systems support competence acquisition by widening access to knowledge, accelerating problem solving and enabling real-time feedback. Yet their responsible use demands capabilities such as critical reflection, creativity and ethical judgement. AI thus operates both as a driver of change and as an enabler of new learning architectures. This double role calls for a reconceptualisation of competence development in which the balance between competences and capabilities becomes a defining feature of future education and labour market systems.

Competence Development – A Review of Theoretical Approaches

Building on the contrast between competence-based and capability-based perspectives, it is useful to revisit the theoretical traditions that support these models. For decades, the competence-based approach has dominated both research and practice, particularly in policy settings where standardisation, benchmarking and certification are prized. Yet it is often criticised for being static and reductionist, tending to overlook the dynamic processes of learning, reflection and adaptation.

As a counterpoint, the capability approach, rooted in the work of Amartya Sen (1999) and Martha Nussbaum (2011), focuses not on predefined competences but on the freedoms and opportunities available to individuals. Development is framed as the ability to exercise agency, to adapt and to learn continuously in changing environments. Education within this perspective cultivates resilience, autonomy and reflective practice, enabling individuals to respond creatively and ethically to new challenges.

At the organisational level, these ideas converge with the theory of dynamic capabilities introduced by Teece, Pisano and Shuen (1997) and further developed by Teece (2007). Dynamic capabilities describe how firms integrate, build and reconfigure competences in rapidly changing contexts. They provide the strategic foundations for renewing individual and collective competences, helping organisations remain innovative and competitive amid disruption. In the AI era, they also influence how employers design learning infrastructures and create the conditions for continuous upskilling and reskilling.

Further theoretical contributions broaden this view of competence development. Kolb's (1984) model of experiential learning, Schön's (1992) notion of the reflective practitioner and Nonaka and Takeuchi's (1995) theory of knowledge creation all understand learning as an iterative, context-sensitive and co-creative process. These perspectives are especially pertinent in periods of rapid technological change, when competences are continually reshaped by new tools and evolving professional environments.

Taken together, these theories suggest that competence development cannot be reduced to the accumulation of isolated skills. It is better understood as a process that combines measurable competences with capabilities that sustain adaptability, creativity and ethical judgement. This synthesis provides the conceptual foundation for analysing how technological transformation is reshaping the logic of upskilling and reskilling.

The Emerging Competence Landscape in Light of the *Future of Jobs 2025*

The distinctions set out above underscore the need to examine how competence- and capability-based framings surface in empirical sources. The World Economic Forum's *Future of Jobs* reports, based on

large-scale employer surveys, catalogues of skills and track their rankings over time. Although the reports offer little in the way of theoretical reflection, their data reveal how competence priorities are evolving amid accelerating technological change.

The 2023 edition was largely competence-oriented, emphasising analytical thinking, technological literacy and attention to detail. Attributes closer to a capability-based logic, such as creativity and resilience, were present but less prominent.

By contrast, the 2025 edition presents a more balanced picture. Whilst analytical and technical skills remain central, adaptability, motivation to learn and social influence have gained in importance. This shift signals a growing recognition of the limits of static competence catalogues and the need for capabilities that enable continuous adaptation.

Taken together, the reports reveal not only an expansion but also a qualitative transformation of the competence landscape. An emerging hybrid model combines the stability afforded by competences with the adaptability conferred by capabilities, laying the groundwork for the analysis of acquisition pathways and learning contexts in the next section.

Changing Perceptions of Artificial Intelligence

Findings from the *Future of Jobs* reports also chart a shift in how artificial intelligence is understood. Whilst earlier debates cast AI chiefly as a disruptive force, recent editions adopt a more nuanced view that recognises risks and opportunities in tandem.

The 2023 edition captured widespread ambivalence: AI was frequently characterised as a disruptive technology linked to automation, job displacement and social inequality. Employers acknowledged its promise but voiced strong concerns about its destabilising effects on established professional structures.

By 2025, the tone had shifted. The *Future of Jobs 2025* report increasingly portrayed AI not only as a source of disruption but also as an enabler of new learning opportunities. Generative AI, in particular, was credited with lowering barriers to access, facilitating problem solving and supporting real-time training. Employers expressed rising expectations that AI would serve as a vehicle for competence development, making learning more personalised, adaptive and responsive to individual needs.

This reframing signals a broader shift in the discourse on AI. An initial preoccupation with threats and uncertainty has given way to a more balanced narrative, in which risks and opportunities are considered in tandem. Employers increasingly regard AI not merely as a challenge but as a resource to be woven into upskilling and reskilling strategies.

The shift matters for two reasons. First, it attests to organisations' capacity to recast technologies once seen as disruptive as instruments of value creation. Second, it signals a growing expectation that AI will not only shape demand for competences but also support their acquisition. In this dual role, AI emerges both as a driver of change and as a partner in competence development. This evolving view also reshapes assumptions about where and how learning should take place, opening the way to new blends of formal education, workplace training and self-directed learning, which are examined in the following section.

Acquisition Paths and Context

As perceptions of AI have shifted from disruption to partnership, attention has also turned to the contexts in which competences are acquired. When coded, the *Future of Jobs* reports reveal not only which competences are prioritised but also where and how they are most often developed. This dimension is crucial for understanding how upskilling and reskilling are embedded in organisational and educational practice, and how responsibility for competence development is distributed across institutions, workplaces and individuals. Importantly, these pathways are highly context-sensitive, reflecting broader structural conditions that shape access to learning opportunities.

Coding of the 2023 edition showed that on-the-job training was the dominant pathway. Employers consistently identified workplace learning as the most effective mechanism for addressing rapidly emerging competence gaps. This reflects recognition that competences need to be developed in environments closely aligned with practical tasks, where new technologies and processes can be integrated directly into daily routines. Workplace learning thus offers immediacy and relevance, but it also remains strongly contingent on organisational culture and the resources available within particular sectors.

At the same time, formal education retained an important role, particularly in providing foundational knowledge and qualifications. Universities and vocational colleges deliver structured programmes that equip graduates with core competences. Yet the pace of technological change often outstrips education systems' capacity to update curricula. As a result, their contribution is increasingly complemented by workplace-based initiatives and shorter, more flexible formats such as micro-credentials. The effectiveness of these pathways, however, varies across national systems, institutional arrangements and professional fields.

Coding of the 2025 edition confirmed and consolidated these trends. Workplace learning remained the dominant context, while formal education retained its significance largely as a provider of foundational competences and a validator of qualifications. The analysis also highlighted the growing salience of self-directed learning, supported by digital platforms and, increasingly, AI-enabled tools. This shift underscores the contextual nature of learning: the ability to benefit from self-directed and AI-supported pathways depends on individual resources, digital infrastructure and workplace recognition. It also signals a redistribution of responsibility, with individuals now expected to engage in continuous, autonomous learning alongside institutional and organisational support.

Taken together, these pathways illustrate the hybrid and context-sensitive character of competence development in the AI era. Formal education supplies foundational competences and certification; workplace learning offers immediacy and sector-specific relevance; and self-directed learning provides flexibility and personalisation but depends heavily on access to digital tools and supportive environments. In combination, they form a multi-layered ecosystem in which competences and capabilities are acquired, validated and transformed.

An ecosystemic perspective underscores the need to integrate diverse pathways into coherent strategies for upskilling and reskilling. It also points to the importance of institutional arrangements that can bridge the gaps between formal education, workplace practice and individual agency, ensuring that competence development remains inclusive, adaptive and aligned with technological change.

Because these acquisition pathways are inherently contextual, no single model of upskilling and reskilling can be universally applied. Effective strategies must adapt to sectoral, organisational and national conditions, while also addressing differences in individual resources. Without such sensitivity to context, competence development risks deepening existing inequalities, privileging those with access to supportive infrastructure and excluding those without. The challenge, therefore, is to design ecosystemic approaches that balance diversity with inclusivity.

Evolving Logic of Reskilling and Upskilling

Findings from the *Future of Jobs* reports indicate a substantive shift in the logic of reskilling and upskilling. Employers continue to stress the urgency of competence renewal, but their strategies are moving away from a narrow transfer of discrete skills towards cultivating adaptability and the capacity for continuous learning.

In 2023, reskilling and upskilling were framed chiefly within a competencebased perspective. Training was conceived as the delivery of predefined sets of competences designed to meet emerging organisational needs. This followed the traditional view of education and training as instruments for filling competence gaps in a predictable, measurable fashion.

By 2025, the framing had shifted towards a more dynamic, capability-oriented logic. Employers recognised that competences acquired through formal programmes can lose relevance quickly, and that the ability to adapt, reflect and learn continuously is at least as important as technical expertise. The reports highlighted the rising role of self-directed learning, short and iterative training formats, and flexible pathways that allow workers to weave together formal education, workplace experience and informal learning.

This shift also signals a redistribution of responsibility for competence development. In earlier models, the burden fell largely on schools, universities and employer led training. Under the new logic, employees are expected to play a more active role in steering their own learning trajectories. At the same time, organisations are expected to create enabling conditions, including access to digital platforms, mentoring and mechanisms for recognising learning. Competence development thus becomes a shared responsibility among employees, employers and institutions.

Yet tensions remain. Employers expect workers to take greater initiative, but not all individuals have equal access to resources and opportunities. Without adequate safeguards, this emphasis on individual responsibility risks deepening inequalities and entrenching digital exclusion. The central challenge, therefore, is to design frameworks that balance personal initiative with organisational and institutional support, so that upskilling and reskilling in the AI era advance inclusive and sustainable competence development.

Consequences for Upskilling and Reskilling

Analysing competence trends and the evolving logics of development reveals significant implications for how upskilling and reskilling are conceived and delivered. These implications affect employees, employers and educational institutions alike, reshaping the wider ecosystem of lifelong learning.

The first consequence is a redefinition of training priorities. As competence life cycles shorten, training can no longer be treated as a discrete episode; it must become a continuous, iterative process. Employers are expected to cultivate environments that support ongoing adaptation rather than sporadic interventions. This shift also complicates assessment and validation. Traditional mechanisms, such as diplomas and certificates, do not readily capture competences acquired informally or with AI-supported tools. New systems of recognition are therefore required, capable of validating dynamic, experience-driven learning whilst preserving credibility and comparability.

A second consequence is the redistribution of responsibility for competence development. Workers are encouraged to exercise greater agency over their learning trajectories, while employers are expected to provide access to resources, mentoring and recognition mechanisms. Public institutions retain a vital role in ensuring access and safeguarding equality of opportunity. Yet this redistribution brings risks. An intensified emphasis on self-directed learning can entrench inequalities, as not all individuals enjoy equal access to digital tools, infrastructure or institutional support. Without adequate safeguards, digital exclusion and uneven opportunity may erode the inclusiveness of competence development.

Finally, the integration of artificial intelligence into learning processes presents both opportunity and challenge. AI is increasingly expected not only to shape demand for competences but also to enable their acquisition through personalisation and adaptability. At the same time, growing reliance on

AI-based tools raises the risk of deskilling: as routine tasks are automated or delegated to intelligent systems, workers may have fewer opportunities to practise and sustain core competences. This dual role demands careful integration into learning ecosystems, supported by ethical oversight, regulatory compliance and transparent governance.

Taken together, these consequences call for a fundamental reconsideration of the architecture of competence development. The future of upskilling and reskilling will hinge on the design of systems that are flexible, inclusive and ethically grounded, balancing individual initiative with organisational and institutional responsibility.

The Employee Perspective

Whilst employer surveys dominate institutional reports such as the *Future of Jobs*, the employee voice is far less frequently represented. DeVry University's *Closing the Gap* (2024) helps to fill this gap by examining how workers themselves perceive the challenges of competence development in the AI era. This perspective is crucial, as it brings to light tensions between institutional expectations and the lived realities of employees.

The study shows that workers recognise the necessity of continuous learning and accept that responsibility for competence development is increasingly shifting towards the individual. Many report engaging in self-directed learning, particularly via digital platforms, to remain employable in rapidly changing environments. At the same time, they express concern about the resources required for such efforts, time, financial investment and access to adequate infrastructure. This reveals a clear tension between the expectation of individual initiative and the unequal distribution of opportunities that may limit workers' ability to meet these demands.

Employees also place strong emphasis on recognition and validation. Informal learning, though central to competence renewal in the AI era, often remains invisible within formal systems of certification and career progression. Workers fear that without institutional mechanisms to validate competences acquired outside traditional settings, their learning efforts will not translate into professional mobility or security. This highlights a persistent asymmetry between employer-driven competence frameworks and employee-driven learning practices.

The DeVry findings confirm that competence development in the AI era cannot be understood solely from the standpoint of employers or policymakers. Employees may assume greater responsibility for their own upskilling and reskilling, but their capacity to do so is shaped by structural factors such as recognition systems, workplace support and access to digital resources. These tensions underscore the broader challenge of designing competencedevelopment infrastructures that are both inclusive and sustainable. They also provide a necessary counterpoint to institutional narratives, reminding us that the future of work will be shaped not only by employers' strategies but also by the everyday practices and constraints experienced by workers themselves.

AI-Supported Dynamic Education Path

The question of whether artificial intelligence can support competence development in practice has become increasingly pressing amid rapid technological change and shortening competence life cycles. The gAI-PT4I4 prototype illustrates the new logic of competence development in action, showing how AI can help to transform learning into an adaptive, interactive process. Developed by Lin et al. (2025), it offers a concrete example of how AI may be integrated into educational infrastructures for Industry 4.0. Rather than treating AI solely as a source of disruption, the prototype 'fights fire with fire', deploying generative systems to address the very challenges they help to create.

The prototype rests on a modular architecture comprising four technical elements: a generative AI module; a retrieval-augmented generation mechanism,; digital twin and virtual-reality environments; and sentiment analysis capabilities. Together, these components create an adaptive and immersive educational system. The generativeAI module produces training content in real time and adjusts it to the user's level and professional context through natural language interaction. The retrieval-augmented generation mechanism ensures the integration of external knowledge so that training materials remain contextually relevant and current. Digital twins and virtual reality provide simulated work environments that mirror real world conditions, enabling learners to experiment and acquire competences without the risks or costs of actual production. Finally, the sentiment analysis module tracks emotional engagement and adjusts the intensity, pace and format of instruction accordingly. Each component maps onto a dimension of the proposed framework, from iterative learning cycles to adaptive feedback that supports learner agency.

The prototype was evaluated under controlled experimental conditions with a cohort of 20 participants. They completed the training tasks successfully in 80 per cent of cases, suggesting the system's effectiveness. The time required to acquire competences was reported to be shorter than under conventional training, although precise comparative data were not provided. These preliminary findings indicate that AI-supported pathways can enhance both the efficiency and the personalisation of learning. They also point to a shift from competence acquisition to competence co-creation, consistent with the proposed new logic.

At the same time, the experiment exposes clear limitations and challenges. The small sample precludes generalisation, and the absence of a control group or detailed baseline measures weakens the strength of any causal claims. Moreover, the controlled conditions

do not mirror the complexities of real world learning environments, where workplace constraints, learner motivation and organisational culture materially shape outcomes. The incorporation of sentiment analysis raises additional ethical concerns, particularly in relation to the collection of sensitive data and the potential for behavioural manipulation.

Despite these limitations, the gAI-PT4I4 prototype represents an important conceptual advance. It demonstrates the possibility of moving beyond rigid, standardised training models towards adaptive systems that respond dynamically to learner needs. The case confirms that competence development is relational and adaptive, and can be co-created through human-AI collaboration. In this sense, it exemplifies a broader paradigm shift in competence development, in which AI is viewed not solely as a source of risk but as an enabling infrastructure for future upskilling and reskilling. Nevertheless, the results remain exploratory and call for further validation through larger-scale, longitudinal studies capable of assessing long-term effectiveness and ethical implications.

Conclusion

Key Insights for Upskilling and Reskilling in the AI Era

The analysis presented in this article demonstrates that upskilling and reskilling in the AI era can no longer be understood as the transfer of predefined skills within static frameworks. The accelerating pace of technological change, together with the shortening life cycles of competences, calls for a new architecture of learning that integrates competence-based stability with capability-based adaptability. This hybrid logic recognises not only the measurable acquisition of technical competences but also the cultivation of reflective practice, creativity, resilience and the ability to collaborate with intelligent systems.

Artificial intelligence plays a pivotal role in this transformation. As illustrated by the gAI-PT4I4 prototype, AI can serve as an enabling infrastructure for personalised, iterative and context-sensitive learning. Such systems have the potential to lower barriers to access, provide real-time feedback and adapt training dynamically to a learner's professional context. The gAI-PT4I4 case shows how the new logic of competence development can be put into practice. At the same time, such systems bring new challenges. The integration of generative AI requires significant investment in infrastructure and capability, while the use of highly sensitive data, such as emotional feedback, raises ethical concerns. Without appropriate safeguards, these technologies may undermine trust, infringe upon autonomy or even facilitate behavioural manipulation.

Limitations of Upskilling and Reskilling in the AI Era

Despite its promise, upskilling and reskilling face critical limitations. Access to learning opportunities remains highly uneven, constrained by time, financial means and digital infrastructures. Recognition systems still lag behind practice, leaving competences acquired through informal or AI-supported learning invisible in many professional contexts. The pace of technological change often outstrips the adaptive capacity of organisations and education systems, placing workers under sustained pressure to renew their competences. Moreover, while AI can enable learning, excessive reliance on automated systems risks contributing to deskilling, eroding human expertise and reflective judgement. These limitations make it clear that upskilling and reskilling are not purely technical endeavours; they require institutional safeguards, a commitment to social equity and robust ethical governance.

Broader Implications and Future Directions

The future of upskilling and reskilling in the AI era hinges on shared responsibility. Employees must exercise agency in shaping their development pathways; employers must enable continuous learning and recognise competences acquired through diverse channels; and public institutions must act as guarantors of inclusion, preventing digital exclusion and ensuring access to the necessary infrastructure. Together, these actors can cultivate competence ecosystems that are flexible, ethical and sustainable.

Several avenues for future research emerge. From the employer perspective, it is important to examine how organisations operationalise competence requirements in recruitment and performance management, and how they design reskilling strategies that balance stability with adaptability. From the employee perspective, further studies should investigate which competences workers themselves regard as most salient for the future, what motivates engagement in learning and how processes of deskilling manifest in the context of AI adoption. It is also essential to monitor the persistent gap between institutional expectations and employee realities. The DeVry survey reminds us that enthusiasm for continuous learning is tempered by concerns about resources, recognition and unequal access, issues that must be addressed if upskilling and reskilling are to be inclusive. At the systemic and macroeconomic levels, future research should explore how public institutions cooperate with business to shape inclusive competence ecosystems, and how informal, AI-supported competences can be recognised and validated. Critical questions also arise about the longterm impact of adaptive AI systems: can they accelerate competence renewal without eroding reflective judgement, and how can they support both individual agency and collective resilience?

Seen in this light, the findings affirm the relevance of the new logic of competence development advanced in this article. Rather than a linear transfer of predefined skills, competence development in the AI era emerges as a dynamic, iterative process of renewal, co-shaped through human-AI collaboration. Recognising future competences as grounded

in capabilities underscores the need for adaptive and inclusive pathways capable of sustaining learning amid accelerating technological change.

Ultimately, despite the uncertainties of a complex and volatile world, artificial intelligence should not be understood merely as a disruptive force. If responsibly governed, it can extend human capacities to learn, adapt and co-create knowledge. In this sense, AI offers not only a new logic of upskilling and reskilling but also an opportunity to open up roles to people whose competences are not captured by formal qualifications.

References

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99–120. https://doi.org/10.1177/014920639101700108

Brynjolfsson, E., & McAfee, A. (2014). *The second machine age: Work, progress, and prosperity in a time of brilliant technologies*. W. W. Norton & Company.

Council of the European Union. (2017). Council recommendation on the European Qualifications Framework for lifelong learning (2017/C 189/03). *Official Journal of the European Union, C189*, 15–28. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32017H0615%2801%29

DeVry University. (2024). *Closing the gap: Upskilling and reskilling in an AI era*. https://www.devry.edu/content/dam/devry_edu/newsroom/2024-devry-ai-report.pdf

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice-Hall.

Lin, Y.-Z., Petal, K., Alhamadah, A. H., Ghimire, S., Redondo, M. W., Vidal Corona, D. R., Pacheco, J., Salehi, S., & Satam, P. (2025). Personalized education with generative AI and digital twins: VR, RAG, and zero-shot sentiment analysis for Industry 4.0 workforce development. *arXiv*. https://arxiv.org/abs/2502.14080

Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company: How Japanese companies create the dynamics of innovation*. Oxford University Press.

Noy, S., & Zhang, W. (2023). Experimental evidence on the productivity effects of generative artificial intelligence. *Science, 381*(6654), 187–192. https://doi.org/10.1126/science.adh2586

Nussbaum, M. C. (2011). *Creating capabilities: The human development approach*. Belknap Press, Harvard University Press.

Schön, D. A. (1992). *The reflective practitioner: How professionals think in action*. Basic Books. https://doi.org/10.4324/9781315237473

Sen, A. (1999). *Development as freedom*. Oxford University Press.

Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal, 28*(13), 1319–1350. https://doi.org/10.1002/smj.640

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509–533. https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z

World Economic Forum. (2023). *Future of jobs report 2023*. https://www3.weforum.org/docs/WEF_Future_of_Jobs_2023.pdf

World Economic Forum. (2025). *Future of jobs report 2025*. https://reports.weforum.org/docs/WEF_Future_of_Jobs_Report_2025.pdf

Agnieszka Skrzymowska is the founder of a start-up developing the AI Tutor concept outlined in this article. Her work reflects a strong commitment to harnessing intelligent technologies in support of meaningful learning. A technology enthusiast and advocate of lifelong learning, she describes herself as navigating her fifth, or even sixth, professional life. Educated in Poland and Germany, she has built her career in international sales, marketing and project management, and now specialises in sales strategy for advanced IT and AI solutions.