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"The journey is more important than the destination." The agency of adult learners in the age of generative artificial intelligence from a constructivist perspective

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Abstract: The integration of generative artificial intelligence (GenAI) within adult continuing education has been observed to be a major contributing factor in the transformation of the conditions under which adults construct their knowledge and professional competencies. This article presents a critical analysis of the existing subject literature, addressing the issue of adult learners' subjectivity in educational environments saturated with GenAI. The analysis adopts a constructivist understanding of learning as an active process of meaning-making based on experience, iteration, and reflection. A particular emphasis is placed on the pedagogical category of error, interpreted within the framework of constructivist theories. A critical analysis was conducted of how GenAI is used in the learning of adult workers, what opportunities and limitations it presents from a constructivist perspective, and what consequences it has for the learner's agency in the context of Industry 5.0. This analysis was based on selected publications. In conclusion, a set of meta-competencies and didactic recommendations was proposed that may help protect the right to make mistakes and preserve the agency of adult learners in the era of algorithmic optimisation.

Introduction

To initiate our examination of adult agency in the era of generative artificial intelligence, it is imperative to draw upon the insights offered by Ryszard Gerlach (2012). Gerlach underscores the necessity for promptly equipping individuals with the competencies necessary to thrive in a rapidly evolving societal landscape. Concomitantly, the author concurs with Ryszard Gerlach's assertion that the sole constant in the contemporary world is the inherent nature of change itself (Gerlach, 2012). The author posits that the modern age is characterised by a paradox: on the one hand, it offers a sense of greater freedom and facilitates diverse experiences and sensations; on the other hand, the intensity of these changes can lead to disorientation in one's life and, ultimately, even a sense of

loneliness or threat (Gerlach, 2012). Education facilitates the identification of one's place in reality and the comprehension of the world around us, the changes taking place in it as well as within ourselves (Gerlach, 2012). The author wishes to note that the backdrop for Ryszard Gerlach's reflections is a world of accelerated change – though at that time not yet algorithmic – but today this dynamic is further radicalised by generative artificial intelligence. In accordance with the assertion of Ryszard Gerlach that the only constant in the present is change, the age of algorithms has directly resulted in the necessity for a constant negotiation of one's own subjectivity. Specifically, the development of artificial intelligence signifies that adults are no longer merely adapting to novel circumstances; rather, they are also acquiring the capacity to function in relation to technology that suggests, corrects, recommends, challenges, and, at times, decides on their behalf. The paradox of freedom and disorientation, as described by Gerlach, assumes a novel dimension within the domain of artificial intelligence. The more tools promise agency and ease of use, the more effortless it becomes to gradually transfer the burden of decision-making and responsibility onto algorithms. This prompts a fundamental inquiry into the agency of the adult learner. Consequently, education cannot be confined to preparing for a changing world; rather, it should foster autonomy in the face of a reality in which human activities – including decision-making, choices, interpretations, and even potential errors – are increasingly being replaced by generative artificial intelligence.

Contemporary adult education finds itself at a pivotal juncture, poised on the precipice of the fifth industrial revolution. This paradigm shift, characterised by its human-centricity, stands in contrast to the technology-driven nature of Industry 4.0. The concept of Industry 5.0 signifies a paradigm shift, wherein the potential for progress is predicated on the close collaboration between humans and intelligent machines. From the perspective of lifelong learning, the fundamental premise asserts that technology should adapt to employees' needs, rather than the other way around. This emphasis places particular weight on learners' autonomy and privacy (Adel, 2022). In this context, generative artificial intelligence (GenAI), although described in 2022 sources primarily through the lens of cognitive systems and machine learning, is becoming a tool that realises the vision of mass personalisation (Adel, 2022). Recent discourse has increasingly emphasised a transition from Industry 4.0 to Industry 5.0. This transition entails a shift in focus from process automation to collaboration between humans and intelligent systems. Additionally, it accentuates the inherent concept of human-centric AI (Adel, 2022; Rane, Kaya, & Rane, 2024). From this perspective, the primary intention behind the integration of artificial intelligence, particularly generative AI, is to support employee well-being, enable the personalisation of solutions, and foster the development of new competencies, rather than

merely increasing productivity (Adarkwah, 2024). In practical terms, this phenomenon signifies an escalating prevalence of scenarios wherein an adult, in the capacity of an employee, concurrently acquires knowledge within the context of the so-called workflow, leveraging GenAI as a repository of knowledge, a source of inspiration, or a facilitator of decision-making support (Adarkwah, 2024).

The objective of this article is to provide a critical and pedagogical analysis of the subjectivity of adult learners in the age of generative artificial intelligence from a constructivist perspective. The author primarily focuses on the tension between the declared vision of human-centric AI in Industry 5.0 and the actual practices of algorithmising the learning process. Additionally, the author examines the effects of these practices on adult learners. The article takes the form of a critical analysis of the existingt subject literature. It is imperative to acknowledge that the objective of this text is not to provide a comprehensive, systematic overview of the research, but rather to facilitate a problem-oriented reading of select texts from 2022–2025 concerning generative artificial intelligence in adult education. This reading is supplemented by references to classical andragogical and constructivist concepts. It should be noted that throughout the remainder of this text, the terms “adult learner” and “adult worker” are used interchangeably. This is done to emphasise the intertwined nature of work and learning processes in the context of lifelong learning.

Generative Artificial Intelligence and Adult Learning Environments in Industry 5.0

The existing literature on Industry 5.0 emphasises that it represents a paradigm in which progress is based on human-AI collaboration. This suggests that the goal is not merely technology itself, but rather technology that supports human and social values (Adel, 2022; Rane et al., 2024).

A critical component of Industry 5.0 is the pursuit of optimal excellence, wherein the operation of machinery is designed to minimise the time and effort required from human labour (Adel, 2022). From an andragogical perspective, however, this raises significant concerns. Conventional adult learning methodologies are predicated on the reflection of experience, with a particular emphasis on the acquisition of knowledge from errors. The provision of immediate, optimal solutions by GenAI has the potential to paradoxically impede the learner’s cognitive development. According to sources, the integration of collaborative robots (cobots) aims to merge human creativity and craftsmanship with the

efficiency of machinery. However, if an algorithm is employed to manage the content generation process with the objective of attaining perfection, the route to this objective – which constitutes the fundamental purpose of education – is significantly reduced or wholly obviated. The potential for adverse consequences arises from the pursuit of business efficiency and the minimisation of losses in the adult education process. This pursuit may result in a diminution of reflectivity, thereby favouring algorithmic guidance (Adel, 2022).

Contemporary scientific research and the employment sector are experiencing a period of accelerated transformation, propelled by the pervasive adoption of generative artificial intelligence. This development is compelling employees and researchers to implement substantial modifications in their prevailing methodologies. People are no longer confined to the practice of tedious analyses or repetitive experiments; rather, they have become curators and interpreters of content generated by algorithms. This evolution of the professional role is predicated on the cultivation of novel digital competencies, among which "AI Literacy" – defined as the capacity to comprehend the inner workings of AI models while maintaining a critical perspective toward them – is paramount. The contemporary employee must cultivate the capacity to meticulously formulate queries and methodically configure systems to procure reliable and pertinent outcomes. This imperative is inextricably linked to the escalating significance of technical proficiencies, such as programming in languages like Python or R, and the adeptness in sophisticated data analysis and visualisation. Concurrently, in the era of pervasive automation, human traits such as creativity, intuition, and heuristic thinking are becoming paramount, facilitating the identification of unconventional pathways for development and the validation of machine-generated conclusions. A concomitant element of this paradigm shift pertains to the ethical responsibility for decisions made based on AI suggestions. Additionally, there is a need for an awareness of risks associated with privacy protection, copyright, and the potential bias of the algorithms themselves. Despite the fact that advanced environments such as NotebookLM or Elicit have the capacity to instantaneously synthesise knowledge and transform static documents into interactive workspaces, users must exercise caution to avoid the phenomenon of "deskilling," which refers to the loss of fundamental research skills due to an excessive reliance on technology (Chodak and Filipek, 2025). In addition, adult workers are expected to demonstrate the ability to engage in lifelong learning (the LLL concept – Life Long Learning), flexibility, and the rapid acquisition of new competencies (Kowalski, 2025). According to reports from the World Economic Forum, the following ten professional competencies are projected to be among the most significant in 2030: evaluation and decision-making; idea fluency; active learning; learning strategies;

originality; system evaluation; deductive reasoning; complex problem-solving; system analysis; and monitoring (Abina et al., 2024, as cited in: Kowalski, 2025). This suggests that prospective employees and job seekers will need to adopt the role of active lifelong learners. This will enable them to cope with stress and adapt in the face of constant changes that threaten the existence of professions (Kowalski, 2025).

Generative artificial intelligence has evolved into a symbol of advanced technology, concomitantly posing challenges in the domains of ethics, law, society, culture, economics, politics, and military development. Generative AI has a broad spectrum of applications across various sectors of the modern economy. Companies such as Google, Amazon, and OpenAI utilise generative models to develop tools that facilitate software development, business process automation, and the generation of diverse content. In the domain of marketing and advertising, Generative AI facilitates the development of customised advertising campaigns and the analysis of extensive data sets. In the domain of creative endeavours, artificial intelligence finds application in the generation of artistic content, including music, images, and text. Additionally, it plays a role in cinematic production, particularly in the realm of special effects and screenwriting. In the medical industry, Generative AI (GenAI) finds application in a variety of contexts, including the analysis of medical images, the transcription of patient and physician voices, the generation of synthetic data for clinical trials, and drug design (Chodak & Filipek, 2025). In the context of rapid digital transformation, adult continuing education has emerged as a pivotal element in adapting to the evolving realities of the labour market. It is noteworthy that 30.3% of all jobs in Poland (approximately 5.08 million) are susceptible to automation or contingent on the developments in Generative AI. A particular challenge is faced by the 4.9% of employees (817,500 people) working in professions with the highest level of exposure, where the majority of daily duties could be taken over by technology. In the process of devising professional development programmes, it is imperative to meticulously consider discrete occupational and demographic categories.

1. A study of office workers revealed that this group is particularly vulnerable to change, with 71.2% of its members performing tasks that can be automated and nearly half (47.2%) falling into the highest-risk category.
2. Gender disparities: The data suggest a necessity for educational support for women, who are more likely to be employed in occupations vulnerable to the impact of GenAI. In the 15–24 age group, 47.8% of women are at risk of job transformation, compared to 22.7% of men in the same age group. This discrepancy is also evident in older age groups. In the 35–44 age range, the percentage of women is 43.4%, and it gradually decreases to 26.1% in the 55–64 age group (Troszyński et al., 2025).

While a significant majority of those who currently utilise Generative AI in their professional activities express a desire to expand its use, a substantial proportion of employees in companies lacking this technology express opposition to its introduction. As demonstrated in the existing research, practice-based education and the development of digital competencies have the potential to be pivotal in facilitating the acceptance of changes in the labour market (Troszyński et al., 2025). The utilisation of technology in the domain of artificial intelligence has precipitated the substitution of human labour with technological alternatives, resulting in employment losses in roles that demand moderate or low levels of skill (Acemoglu & Restrepo, 2018; as cited in Kowalski, 2025). However, it is important to acknowledge that the advancement of AI has been shown to enhance production, optimise equipment efficiency, and elevate the skillset of employees, thereby stimulating the emergence of new employment opportunities (Aly, 2022, as cited in: Kowalski, 2025).

The future of work is contingent upon the symbiotic relationship between humans and machines, wherein the automation of routine tasks (even in the form of fully automated "dark labs") enables individuals to prioritise strategic planning and innovation. This, in turn, precipitates profound alterations in employment structures and the requisite qualifications (Chodak and Filipek, 2025).

The Agency of Adult Learners in the Age of Algorithms

The following statement by Józef Kargul (2001, p. 8) serves as a foundational point of departure for any discourse on the agency of adult learners:

"Human education is inextricably linked to human action and activity; consequently, the domains of education align with the spheres of human life. The cultivation of the intellectual life of the human individual occurs within the domain of education, which is a form of activity characteristic of the species *Homo" (author's own translation).*

Kargul's observation underscores the connection between education and the real-world spheres of human activity. It is imperative to understand this connection not as learning alongside life, but within its flow – namely, in the very same spaces where we work, take responsibility for others, or make decisions and bear their consequences. From the perspective of the author's reflections, it can be concluded that the subjectivity of the adult learner does not unfold in the isolated realm of education, but rather across the entire network of their activities: professional, familial, civic, and, in the present day, additionally strongly mediated by digital technologies and algorithms. In order for education to continue to serve as a catalyst for the intellectual life as described by Józef Kargul, it is imperative

that it safeguard adult agency in the very areas where it is most vigorously endorsed and potentially superseded by GenAI. These areas include routine activities, problem-solving, and decision-making.

In this context, personalism emerges as a particularly salient concept, as it posits the human being as an emanation of pure subjectivity, thereby precluding the possibility of its equating with other objects in the real world (Gerlach, 2012). The foundation of all andragogical activities is precisely this personalistic view of the human being. It is widely accepted that the most significant, constructive attribute of human beings is rationality – defined as the capacity to comprehend the world and oneself – and freedom, understood as the ability to select values and courses of action autonomously (Matulka, 2000). In the context of the generative AI era, adult education must not reduce the human being to the role of a technology user. Instead, it should consistently protect and strengthen the human capacity for autonomous thinking and choice, including in relation to algorithms.

In order to comprehend the implications of artificial intelligence for the educational process, it is imperative to deliberate on methodologies that can cultivate the learner's sense of agency, self-awareness, and critical thinking. Additionally, it is crucial to explore strategies that can promote responsibility for the outcomes of their own decisions and actions (Michałowska, 2025). Three fundamental approaches to cultivating student agency can be delineated as follows. These three elements are critical to the process of critical thinking: self-reflection, intellectual honesty, and intellectual openness. In addition, engaging in dialogue with others is essential, both within the learning community and in the broader cultural and social context (Siegel, 2004, as cited in: Michałowska, 2025). The concept of agency, as it pertains to the utilisation of Generative AI technology, is predominantly characterised by the accentuated role of humans as indispensable overseers. This oversight responsibility entails the critical verification of results and the execution of final decisions. The concept of the "humanistic factor" is emphasised, encompassing empathy, relationship building, and an understanding of social and biographical contexts – areas in which the human factor remains indispensable. Furthermore, the authors underscore the significance of employee agency by promoting the conscientious management of one's career trajectory and proactive engagement in the evolution of workplaces during the technological transformation process (Troszyński et al., 2025). This compendium of methodologies for cultivating autonomy unmistakably evinces that the emphasis is not predominantly on the utilisation of instruments, but rather on the capacity to adopt a critical stance toward their recommendations – even when they are expeditious, precise, and alluring in their expediency. In the context of GenAI, these three areas – critical thinking, self-reflection, and dialogue – are essential for safeguarding the cognitive autonomy of

adult learners. These practices enable technology to support, rather than supplant, their own reasoning and responsibility for decisions.

In considering the role of education in the formation of human subjectivity, it is pertinent to refer to Gert Biest's concept of an "event-based pedagogy." The conceptual framework under scrutiny herein is predicated on the philosophical tenets espoused by Emmanuel Levinas, which advocate for an ethical approach to subjectivity. This ethical approach is exemplified, in part, by the following interrogative inquiries. The fundamental question that guides this inquiry is: How does the subject exist? The following inquiry seeks to elucidate the manner in which this phenomenon manifests itself. The text raises the question of how the entity in question assumes its individual responsibility. The author calls for the reorganisation of the education system and the teaching-learning process in such a way that situations conducive to the emergence of subjectivity can arise. It is imperative to implement educational methodologies that facilitate students' self-identification as active and responsible agents. However, as Biesta's theoretical framework elucidates, the role of the teacher transcends the mere passive transmission of knowledge. Instead, it necessitates meticulous engagement with students, along with an acknowledgment of situations characterised by uncertainty and risk (Biesta, 2016, cited in: Rusek, 2024). Gert Biesta posits that the concept of "unfolding of subjectivity" signifies an openness to the unknown and the unpredictable. This phenomenon contributes to a shift in educational thought, moving away from a focus on outcomes, fulfilment of requirements, or goals. Instead, it fosters the discovery of a novel type of educational response and responsibility. In the context of a technicised world, there is a need to create situations that allow for the emergence of subjectivity and existence in dialogue (Rusek, 2024).

The Pedagogical Concept of Error from a Constructivist Perspective and Adult Learning in the Age of GenAI

The process of learning from mistakes is a natural strategy employed in a variety of everyday situations. It has been observed that some individuals demonstrate a higher level of proficiency in this regard, while others exhibit a tendency to commit the same errors repeatedly. Furthermore, individuals exhibit considerable variation in their tolerance levels for their own mistakes (Kopaczyńska, 2020). However, it must be acknowledged that people commit a multitude of errors, both significant and minor, as asserted by Iwona Kopaczyńska (2020). In academic settings, errors are often met with disapproval, particularly in the context of formal education. In conventional pedagogical approaches, missteps are seldom regarded as indicative of a child's developmental process or their

reasoning abilities. A learner's mistake can serve as a significant source of insight for an instructor, who can observe the learner's cognitive processes, personal knowledge that guides them in the educational process, the meanings they ascribe to the world and their own actions, and how they understand the world (Kopaczyńska, 2020).

In the context of constructivist theories, the concept of pedagogical error is undergoing a reevaluation. Specifically, it is no longer regarded as an indicator of a competency deficit subject to evaluative sanctions. Rather, it is now understood as an inherent and desirable component of the developmental process (Kopaczyńska, 2020). In the current era of generative artificial intelligence, a period characterised by the generation of content that evokes hallucinations or logical errors, this category assumes a novel epistemological dimension. It functions as a catalyst for subjective cognitive activity, thereby compelling the learner to transition from passive data consumption to critical analysis and hypothesis verification.

In the field of education, constructivism draws from two primary sources: psychological constructivism, which is influenced by Jean Piaget's theories, and social constructivism, which is informed by Lev Vygotsky's theories and the ideas of Jerome Bruner (Philips & Soltis, 2003; as cited in Kopaczynska, 2020). Psychological constructivism, rooted in Jean Piaget's theory, defines development as a process of continuous reorganisation of cognitive structures. A pivotal juncture in this process is the disruption of equilibrium, precipitated by an experience that stands in contradistinction to the individual's prior expectations. From this perspective, an error – whether made by a student or generated by an AI system – triggers a cognitive conflict. The process of cognitive reconstruction is initiated by the following factors: the process of assimilation and accommodation is stimulated, leading to a more profound reconstruction of knowledge. Independent thinking strategies are activated, even if their immediate outcome is inadequate. Cognitive curiosity is sparked, which in turn boosts motivation and encourages the asking of exploratory questions (e.g. What will happen if [...]?) (Kopaczyńska, 2020). Within the paradigm of GenAI, error functions not as a hindrance but as a catalyst for pedagogical endeavours focused on enhancing performance and fostering comprehension of underlying issues. The emphasis shifts from mere avoidance to comprehensive analysis, ensuring that errors are not merely corrected but thoroughly examined to optimise performance and expand understanding. The sociocultural perspective, as articulated by L. Vygotsky and J. Bruner, posits that knowledge is not merely replicated but rather constructed through intersubjective interactions within the context of social exchange (Vygotsky, 1971). In this perspective, the occurrence of an error during interaction (including with an AI system acting as the so-called "Other") serves as a medium for the establishment of

meanings. Confrontation with a divergent perspective, even one that is erroneous, serves a stimulating function. This confrontation forces cognitive decentralisation, allowing the individual to move beyond a particular point of view and understand alternative strategies for processing information. Furthermore, it awakens critical thinking and the need for rigorous argumentation of one's own positions. Finally, confrontation with a different perspective transforms error into an inspiration to learn more, which fosters the discovery of previously unknown tools for intellectual work (Kopaczyńska, 2020).

Constructivist pedagogy is predicated on the notion that the process of acquiring knowledge possesses a greater educational value than the final product itself (Kopaczyńska, 2020). The efficacy of learning is contingent upon the extent of engagement in the active assignment of meaning to phenomena, as opposed to the mere reproduction of predefined algorithms. In the context of the pervasive utilisation of GenAI tools, which provide immediate results, the learner's intellectual autonomy assumes a paramount importance. The concept of metacognition is generally accepted as a form of self-regulation, which enables individuals to proactively manage their cognitive processes. This process encompasses the autonomous formulation of questions, the validation of responses, and the discernment of courses of action in situations of uncertainty. Within this framework, error functions as indispensable feedback, thereby facilitating the development of adequate self-knowledge as an agent and a reflective being.

The Duality of Opportunities and Limitations in GenAI from a Constructivist Perspective

The integration of generative artificial intelligence (GenAI) with adult continuing education gives rise to a profound dualism that, from a constructivist vantage point, intersects with the very core of the learning process. This tension, manifesting as a dichotomy, can be delineated as follows: on one hand, there is the active construction of knowledge, and on the other, there is the algorithmic delivery of ready-made results. Constructivist theory posits that learning is an iterative process based on experience and reflection, wherein error serves a regulatory function (Worek, 2025). Concurrently, data demonstrate a substantial rate of adoption of these instruments: a study by Troszyński et al. (2025) revealed that 37.3% of Polish individuals who utilise AI in their personal lives do so for educational purposes, seeking support in understanding complex issues.

The opportunities presented by algorithmisation are predominantly associated with the notion of mass personalisation and the establishment of digital scaffolding for the

learning process. GenAI tools have the capacity to adapt the pace and style of learning to individual needs, a feature that is particularly salient in heterogeneous groups, such as classrooms with students of diverse abilities. For instance, 28% of teachers utilise AI to provide support to students with special educational needs (Pyżalski, 2025). In a professional setting, this potential is translated into measurable efficiency. Surveyed specialists indicate the possibility of reducing design time (e.g. UI/UX) by up to 40%, which theoretically frees up cognitive resources for strategic and creative activities (Troszyński et al., 2025). From a constructivist perspective, Generative AI can function as a virtual collaborator that, through dialogue, fosters curiosity and helps overcome creative blocks (Adel, 2022; Troszyński et al., 2025).

Nevertheless, this same potential also engenders considerable limitations and risks, which can result in the erosion of agency. The most salient challenge pertains to the algorithms' pursuit of "maximum perfection" (Adel, 2022), a pursuit at odds with the pedagogical value of error. In the event that an algorithm furnishes an immediate, optimal result, the adult learner is deprived of the (metaphorical, titular) path – that is, the process of reasoning and argumentation. This concern is reflected in survey data, which indicate that 53% of working Poles believe that GenAI technology poses more risks than benefits, and 42.6% fear that using these tools will lead to a decline in their reasoning abilities and a cognitive dependence (Troszyński et al., 2025). Another critical issue is the reliability of the generated content. The phenomenon of language model hallucinations, wherein false information is presented as factual, occurs with a frequency ranging from 2% to over 20%, depending on the model (Zarecki, 2024, as cited in: Pyżalski, 2025). From a constructivist perspective, the absence of algorithmic transparency in the "black box" hinders critical verification of knowledge, which may result in superficial learning (Juchniewicz, 2025).

Practical recommendations for designing adult continuing education programs

A critical review of the existing literature and the author's aforementioned reflections suggest the following practical recommendations for the design of adult continuing education:

1. Adult continuing education should adhere to the principle of "try it yourself first, then GenAI". The underlying principle asserts that all tasks, whether educational or related to professional development, should be meticulously designed to ensure that adults first define the problem, formulate hypotheses, and make decisions independently.

Only after this process is it appropriate to compare their solution with the algorithm's suggestion. This approach ensures that technology serves as an enabler, enhancing the learning process rather than substituting for it.

2. The deliberate incorporation of errors into teaching scenarios is a deliberate pedagogical strategy that functions as a constructive element. Rather than seeking to eliminate all uncertainty, it is possible to devise scenarios of "controlled missteps," such as tasks with intentionally incomplete data that encourage varied interpretations, or exercises in which an adult is tasked with identifying and correcting errors (whether their own or those generated by GenAI). Such practices enable the preservation of the pedagogical value of learning from mistakes in conditions where technology can immediately neutralise errors.
3. It is imperative for continuing education programmes to incorporate the explicit development of meta-competencies related to artificial intelligence. The author's intention is not to imply that efficient utilisation of tools is not a relevant factor, but rather to emphasise three interconnected competencies: a fundamental understanding of the mechanisms underlying their operation, the capacity for critical evaluation of their reliability, and the implications of the generated responses, and the deliberate discernment of when the implementation of GenAI is conducive to personal growth and when it becomes an expedient yet ultimately unproductive shortcut.
4. In the realm of adult education program design, it is imperative to accentuate the community aspect. The utilisation of GenAI should not result in the isolation of learners from their peers; rather, it should serve as a catalyst for dialogue, whether in groups, project teams, or mentoring relationships. A discussion of the use of these tools, the circumstances in which they are beneficial, and those in which they compromise our autonomy is just as essential as the practical application of the technology's capabilities.
5. Institutions that are responsible for adult education – both formal and non-formal, including schools, universities, employers, and non-governmental organisations – must establish clear, transparent guidelines for the use of GenAI. In practice, this entails the establishment of limits on automation in developmental tasks (i.e. domains where the complete delegation of work to an algorithm is deemed unacceptable), the assurance of the right to maintain a critical distance from these tools, and the cultivation of a culture that prioritises cognitive autonomy and the adult learner's responsibility for their own educational journey over immediate outcomes.

In the current era, characterised by the Industry 5.0 paradigm and the ongoing cyborgisation of educational processes, the preservation of the authentic agency of adult learners

necessitates the cultivation of advanced meta-competencies that extend beyond the mere instrumental use of technology. It is imperative to cultivate critical algorithmic awareness, enabling AI systems to be regarded as collaborative partners while safeguarding the thought process from the pitfall of unreflective, algorithmic optimisation. The subsequent set of competencies is designed to ensure the preservation of cognitive development and to reinstate error as a pivotal agent for growth within a society that is increasingly prioritising immediate perfection:

1. A critical review and verification of content is essential for effective critical thinking. The capacity to methodically assess the outcomes of artificial intelligence (AI) in terms of their practicality, dependability, and the likelihood of erroneous or delusional outcomes. This competency entails the meticulous verification of the factual, legal, and substantive accuracy of received messages prior to their acceptance as knowledge.
2. Algorithmic Awareness: It is imperative to possess a comprehensive understanding of the logic, limitations, and social impacts of AI systems. This profound understanding enables us to discern when algorithmic recommendations stem from personalisation, profiling, or attention optimisation. This understanding is imperative to avoid perceiving technology as a neutral instrument and to acknowledge its role in shaping our cognitive processes.
3. Prompt Engineering: The ability to create effective natural-language prompts that precisely define tasks and context is paramount. This ability enables the efficient delegation of technical tasks while maintaining control over the process. The pivotal element in this regard is the transition from general commands to detailed instructions that reflect the learner's intent.
4. Metacognitive Reflection: The capacity to supervise one's own cognitive processes and introspect on the obstacles confronted during task resolution, thereby ensuring that artificial intelligence does not supplant cognitive exertion but rather stimulates it. This includes an awareness of the risk of cognitive offloading, which can lead to the atrophy of independent reasoning.
5. Ethical responsibility and moral agency: The willingness to assume responsibility for decisions made with the involvement of intelligent systems, and to ensure that technology is trustworthy – that is, lawful, ethical, and reliable. In this context, agency signifies the acknowledgment that humans persist as the primary originators of meaning and value.
6. A culture of error and experimentation: The capacity to perceive errors as an inextricable element of learning and a catalyst for authentic growth, thereby offering a counterbalance to the algorithmic pursuit of immediate perfection. This competency

fosters mental resilience and the courage to seek unconventional solutions that extend beyond the ready-made frameworks of AI.

7. Managing Digital Hygiene and Well-Being: The ability to consciously establish boundaries in interactions with technology, prevent technostress, and avoid excessive exposure to digital content. This encompasses the necessity of preserving real-life social interactions and environmental exposure beyond the confines of the virtual realm.
8. The adaptability and a growth mindset is conducive to success in this field. The ability to demonstrate a commitment to ongoing professional development, including the pursuit of advanced skills (upskilling) and the acquisition of new competencies (reskilling), in response to the dynamic shifts occurring within the labour market. This notion is rooted in the hypothesis that cognitive faculties can be cultivated through deliberate practice and that technological interventions can facilitate this process.
9. Inter-subjectivity and social intelligence: The cultivation of soft skills, empathy, and the capacity to establish authentic interpersonal relationships represent qualities beyond the capacity of AI. The exchange of ideas within an educational community, facilitated by technology, serves to strengthen subjectivity. Rather than substituting collaboration, technology functions as a platform for it.

The realisation of the vision of Industry 5.0 in adult continuing education necessitates the acknowledgement that technology should serve as a complement to, rather than a substitute for, human agency. From a constructivist perspective, the process of acquiring knowledge – with all its challenges and errors – is of greater pedagogical significance than the final product generated by artificial intelligence. Indeed, trustworthy information is not merely the product of calculations; rather, it is the result of a complex process of human meaning-making. The ultimate success of the digital transformation is contingent upon safeguarding the agency of adult learners from the fallacy of algorithmic infallibility and preserving the distinctive, so-called human touch in educational processes.

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