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Artificial Intelligence in Professional and Vocational Training

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and Charles-Antoine Gagneur

Abstract This chapter explores challenges linked to AI integration in professional training, emphasising the need to question the learning analytics generated during activities involving humans or living entities. The intersection of initial and ongoing training poses a design challenge: making AI tools acceptable for both training and the workplace. This chapter critically examines the nature and quality of the initial data and learning analytics using educational data mining through three case studies of adaptive learning environments. The first case study addresses

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the challenges of modelling Comté cheese manufacturing. The second case study describes Silva Numerica, a digital forest simulator, exploring how AI, as a learning tool, can contribute to realistic modelling while addressing didactic obstacles. The third case delves into AI's role in automotive mechanics training, emphasising the need for visibility in cognitive inference processes. The chapter concludes by addressing data reliability concerns in AI systems and proposing education and training strategies to overcome such challenges.

Keywords Professional training · Vocational training · Learning analytics · Artificial intelligence · Digital learning environment

Introduction

In order to develop an AI system, it is essential to possess dependable data that can be utilised to facilitate the process of teaching and learning. In vocational training, this type of data is distinguished by its emphasis on practical knowledge and the use of informal, deliberative, and adaptable regulations in the workplace, with a focus on productivity. A second challenge in developing an AI in professional training lies in maintaining the educational value of real-life experiences, which encompass a wide range of situations, various approaches, and different outcomes. This must be done while simultaneously taking into account the applicability of real-world work scenarios for educational objectives (Ciavaldini-Cartaut et al., 2022).

The challenges of using AI-powered smart tutors present several obstacles: (i) providing feedback for human interactions over extended periods, and (ii) the absence of detailed descriptions regarding the actual work. This chapter delves into the criticisms and questions surrounding AI in professional training, specifically in the context of alternating between formal education and workplace training. The analyses are grounded in the cultural, anthropocentric, and socio-technical paradigm of technology use (Albero, 2019). AI can be considered as instruments for operations, processes, and access to information supporting the teaching-learning process (Folcher & Rabardel, 2004). While AI can enhance cooperation and support learning analytics, challenges arise in

applying it to complex, ‘with and for the living’ activities where observable behaviours fall short in capturing the intricate cognitive, adaptive, and creative processes required in work situations. Learning analytics, in this context, proves limited in comprehending these nuanced processes (Albero, 2019).

This chapter critically examines the nature and quality of the initial data and learning analytics using educational data mining. Empirical illustrations include the adaptive reasoning challenges in Comté cheese manufacturing (Chrétien et al., 2020) and the e-Fran research, Silva Numerica (<https://silvanumerica.net/>), focusing on a forest management learning environment (Chiron, 2018; Guidoni-Stoltz, 2019, 2020). The latter explores how AI, as a learning tool, can contribute to realistic modelling while addressing didactic obstacles. The third illustration delves into AI’s role in automotive mechanics training (Gagneur & Vassout, 2019), emphasising the need for visibility in cognitive inference processes.

The Use of Professional Analytics in Designing AI Tools

In both social and educational contexts, discussions on professional skills and tasks abound. Yet, complexities arise when considering the actual work done within companies, primarily due to the proprietary nature of productive work and the inherent difficulties of documenting intricate work processes. Furthermore, very little is known about the specific and often diverse processes required to complete a job, particularly when that job requires collaborating with other humans in a dynamic environment.

This chapter addresses the challenge of identifying relevant data points for evaluating learning in professional environments when the work done includes a mix of discretionary and prescribed tasks. Companies often rely on procedures, but the associated knowledge is frequently disconnected from the actual complexities of real workplace activities. Furthermore, while simulations can provide more realistic situations from which to study, their effectiveness in regard to teaching or learning is well-documented within the field of professional didactics.

In the realm of school education, obtaining tangible data seems more straightforward, with established scientific and didactic knowledge. However, the world of work presents challenges where efficiency is correlated with immediate or long-term results, making judgments about individuals' work and the data associated with that work, 'awkward to say' (Dujarier, 2010). Vocational training stands at the crossroads of using tangible learning analytics (Knight & Buckingham, 2017) and data faithful to work situations (Chiron, 2018). The chapter concludes by addressing the challenges of developing AI tools or implementing machine learning algorithms for work situations, where the initial data may lack the precision necessary to foster effective learning.

Exploring AI in Vocational Training: The Case of French Comté Cheese

The production of French Comté cheese (Chrétien et al., 2020) is well-documented and offers insights into the challenges and potential of AI in vocational training. Despite extensive data on standardised procedures, including factors like cow types, weather, and soil conditions, a crucial anthropocentric perspective reveals a gap in understanding essential variables. These variables, which influence a cheesemaker's decision-making for distinct flavours, remain elusive. As such, while procedural data could be used to train AI tools for this type of vocational environment, the inclination towards industrialised processes over contextual reasoning presents a socio-technical problem: manufacturers and management tend to prioritise procedures, not reasoning, when designing their professional training. This bias raises questions regarding data selection and the role of humans in AI design, distinct from the context of school education.

The case of Comté cheese production highlights workplace learning, prompting inquiry into how AI could impact learning in professional settings. Littlejohn (2017) notes challenges in modelling complex, dynamic environments due to inadequate information sensors. In Comté cheese manufacturing, perceptual and gestural dimensions, crucial for the cheesemaker's decision-making, lack suitable sensors for AI interpretation. The political and technical intricacies of collecting tangible

analytics pose questions about industry willingness, standards, and components necessary for documenting an AI system. While high-risk industries have addressed these challenges, AI's impact in vocational training extends to other sectors, necessitating a broader exploration of its potential influence.

AI Support in Simulated Environments: The Silva Numerica Project

One potential application of AI in vocational training is its role as a learning partner. This involves utilising AI as a support tool to enhance various aspects of professional learning. For instance, AI could help document reliable data for designing simulations that replicate work situations, especially those challenging for future professionals to access. It could also contribute to improving the handling of critical situations, be it in product development, manufacturing processes, or collaborating with people. Consider the risk-laden scenarios of taking-off and landing a commercial aircraft at a congested airport during peak travel season. An AI tool could document the processes necessary for a pilot to complete these tasks, however, it would be unable to articulate the subtle or invisible learnings, acquired through repetition, over extended periods of time. AI would face a similar challenge in documenting the processes and actions related to managing a forest within a complex ecosystem that evolves over long periods of time, absent human intervention. The Silva Numerica project (Guidoni-Stoltz, 2019, 2020) has meticulously gathered data documenting forest management work with the goal of designing a digital learning environment that can capture the intricacies of this field. Despite their efforts, the virtual simulator they developed for educational purposes encounters significant limitations. First, the natural developmental processes it seeks to replicate are inherently complex, lacking a ready-made global model for training or a comprehensive database. This complexity is further compounded by its dependence on contextual factors such as climate, commercial outlets, and specific silviculture goals and practices (Mayen & Lainé, 2014). Similar challenges are highlighted in the study by Chrétien et al. (2020) concerning cheese

making. While the manufacturing process, well-documented with precise and reliable data, lends itself to potential AI development, the ways in which these processes are implemented remain implicit. Therefore, the lack of thorough data becomes apparent when considering the variability and diversity of real-world work situations. For these same reasons, the design and use of AI-powered simulators also become a challenge. Some studies, including recent work by didacticians like Vadcard (2013, 2019), underscore the nuanced nature of simulation effectiveness. They argue that achieving realism in simulating complex and dynamic environments doesn't guarantee training effectiveness. In fact, excessive realism might be counterproductive, as modifying reality for pedagogical purposes is often a prerequisite for transforming situations into meaningful learning experiences. For example, *Silva Numerica's* forest simulation, while relatively realistic based on regular high forest silviculture of sessile oaks, introduces a simplified representation of trees as 'lollipop sticks'. This departure from realism serves as a semiotic resource for learning, aiding in tasks like selecting trees based on their ability to contribute to forestry development.

This raises the question: to what extent can AI contribute to modelling a training process based on databases of work tasks, outside of practice situations? Furthermore, how can AI facilitate modelling and simulations when dealing with poorly documented phenomena and processes?

The Challenges of Utilising AI and Intelligent Tutors in Professional Learning

A pivotal inquiry in our exploration pertains to the capacity of AI to furnish pertinent feedback for learning. As elucidated by Hwang et al. (2020), the concept of AI as an intelligent tutor is prevalent in the literature. The crux of AI's use in professional training resides in its ability to scrutinise learner activity and generate meaningful feedback. This poses a formidable challenge, as it hinges on the expectation that AI technologies can dissect a learner's actions on the machine, explicate the validity or invalidity of their achievements, and assess the associated learning quality. In professional domains like forest management, where

diverse and context-dependent outcomes may be valid, the interpretative challenge for AI intensifies.

AI's interpretation must acknowledge that conformity with a result doesn't necessarily imply the learner's comprehension of underlying strategies, procedures, or professional knowledge. Moreover, AI's feedback cannot be solely aligned with good practice or standard reasoning, as various other legitimate reasonings may lead to comparable outcomes. Hence, establishing indicators that can evaluate a learner's acquired knowledge or identify difficulties associated with the learning experience continues to complicate the use of AI tools in these environments.

The ensuing question revolves around the potential of AI, coupled with learning analytics, to tailor guidance based on user knowledge and learning. Can AI leverage its touted abilities in machine and deep learning to detect errors or recurring difficulties, subsequently adapting its feedback to that of a human teacher? We perceive significant risks in relying solely on AI for this purpose. The self-learning capacity of artificial neural networks is constrained by their indexing to an incomplete digital image rather than reality. Additionally, AI's pursuit of concordances between datasets to extract regularities diverges from the maieutics of discrepancies inherent in tutoring practices. As suggested by Savoyant (2006), AI could be useful for a first step: to work out a task (what I have to do), but not to assimilate it (how I have to do it).

While it is conceivable that AI may achieve a level of finesse in detecting pedagogically relevant discrepancies within texts or simulated activities, challenges persist in indexing AI to remote contextual elements. In vocational training, the indexing process involves tacit professional knowledge, which may be distant from the immediate conditions of action, posing challenges in acquisition, selection, and relevance that current digitisation capabilities cannot fully automate.

The example of the Silva Numerica project underscores these challenges. Despite efforts to record learner actions and responses, the complexity of the resulting data made it challenging for trainers to conduct effective debriefings. Analytics tied to individual actions proved difficult to interpret and utilise during training, prompting a shift to follow learner activity in the virtual environment and incorporate activity

data in the post-training evaluation. This pragmatic adjustment highlights the limitations of realising the idealised concept of an intelligent tutor. The integration of AI in professional learning, while holding promise, necessitates cautious consideration of the complex, nuanced nature of real-world professional situations (Casilli, 2019). Sole reliance on AI, devoid of teacher supervision, for learning maieutics and guidance based on discrepancies, remains a formidable challenge. The examples presented underscore the intricate interplay between AI and the multifaceted realities of professional training contexts.

Conclusion: Navigating the Terrain of AI in the Field of Professional Learning

In this chapter, we began our exploration by examining the potential benefits and existing constraints surrounding the integration of AI in the instruction and acquisition of vocational skills within training programmes and workplace contexts (Ciavaldini-Cartaut et al., 2022). We elucidated a pivotal element crucial to unlocking the value of AI in these applications: the imperative of rendering work data, encompassing gestures, situations, circumstances, reasoning, and the learning data itself, both reliable and tangible.

While the trajectory of AI's evolution remains challenging to forecast due to the rapid advancements in machine learning techniques, we contend that a persistent challenge lies in tethering these processes to reality. This challenges the very essence of AI integration, extending beyond a mere technical hurdle to a fundamental, enduring constraint. Consequently, the quest for tangibility and usability of work data mandates a collaborative approach with professional organisations. This involves designing learning support tools that leverage access to such data through collaborative research initiatives, surmounting the socio-technical barrier of professional scepticism towards work data, and facilitating access to AI-embedded work reasoning and knowledge for educators, trainers, and learners.

The realisation of tangible work data necessitates a multifaceted strategy, including the unveiling of real work nuances, the discernment

of reasoning processes, and the empowerment of individuals to master AI as a tool, as articulated by Folcher and Rabardel (2004). We have underscored the need to collaborate with educators and trainers when crafting teaching assistance tools as a prerequisite for both seamless AI integration into pedagogical practices and its general wider acceptance. Beyond individual proficiency, the effective utilisation of AI in learning support requires a broader reconfiguration of tools, fostering an ergonomic evolution that aligns with the dynamic needs of stakeholders.

In conclusion, through the studies presented, this chapter highlights the challenges of integrating AI into vocational training: the difficulties of quality data collection and dealing with the complex interplay between technological developments, collaborative efforts, and socio-technical dynamics. The journey forward demands a thoughtful and collaborative approach, navigating the evolving landscape of AI in education and professional learning.

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