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Creative Application of Artificial Intelligence in Education

Alex Urmeneta and Margarida Romero

Abstract The chapter commences by presenting the emergence of artificial intelligence (AI) in the field of education. It aims to provide an overview of the AI environment in education, highlighting the importance of a nuanced comprehension of its effects, ethical implications, and potential to stimulate innovative teaching methods. The chapter explores the historical background of technological interventions in education and takes a critical approach to examining the potential benefits and drawbacks of AI. It also considers the sociocultural and creative aspects of using AI in education. AI has typically focused on imitating human intelligence. Within the realm of human abilities, we recognise various degrees of creative involvement in AI in education, which demonstrates its capacity to revolutionise learning experiences. At the most advanced

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stages of creative involvement, we explore the possibilities for collaboration between human intelligence and AI, suggesting a viewpoint of human–AI co-creativity. The chapter also outlines the book’s structure, which consists of three main sections: the creative engagement approach, real examples in K-12 education, and advances and prospects in higher education. The different chapters envision not only the acculturation and education of AI, but also the potential of human–AI collaboration to support learners in expressing their unique talents and developing expansive, AI-supported learning initiatives.

Keywords Creativity · AI education · Artificial intelligence · Hybrid intelligence · Human–AI collaboration · K-12 education · AI ethics · Creative pedagogies

Introduction

The recent availability of Artificial Intelligence (AI) applications has increased public interest and sparked curiosity about the potential of Large Language Models (LLMs) and other forms of generative AI. These models, enabled by parallel breakthroughs in data management, cloud computing, and artificial neural networks (Zhai et al., 2021), are viewed by some as the catalyst for the fourth industrial revolution (Bühler et al., 2022). One might wonder what the scholars who first used the term “Artificial Intelligence” in the late 1950s would think of its nearly 70-year journey to our current understanding and definitions of AI. Their definition of AI as “the science and engineering of making intelligent machines” seems modest given where we are today—still seemingly at the dawn of AI’s potential. Perhaps this is why there has been much debate in recent years about what constitutes AI, as different stakeholders seek to assign meaning that aligns with their own needs and goals (Samoli et al., 2020). It is through this lens that educational stakeholders are now considering the role of AI in education as they seek to define its use cases, impact, and potential challenges going forward.

Education, ever ripe for change in response to current educational and societal challenges, has been earmarked as one of the domains in

which the benefits of AI can be developed, but also an area that necessitates adherence to rigorous ethical principles. It is crucial for technology to prioritise the protection of privacy and the well-being of students and their communities. The study of the potential of AI for education opens many different perspectives that need to be considered within the context of Technology Enhanced Learning (TEL) and its evolution in recent decades. This stands to reason given the complex role technology has played over the years in creating expectations around its ability to support the teaching and learning process. From headphones to projectors to calculators and personal computers, the internet, smart devices, and MOOCs, each iteration carried with it a level of optimism and promise that this would be the technological advancement that transformed education for the better (Escueta et al., 2017, Higgins et al., 2012, Zhai et al., 2021). Nevertheless, such optimism warrants scrutiny when viewed through the lens of techno-solutionism (Selwyn, 2022), a perspective that emphasises a critical examination of technology's role and its limitations in solving complex societal issues such the Sustainable Development Goals (SDGs). While technological advancements have improved some processes and supported the creation of others, the techno-solutionism perspective (Elfert, 2023). Urges us to question the effectiveness of these innovations and whether they genuinely address root challenges or merely present a valueless transformation of the teaching and learning process. This sociocritical perspective in TEL encourages a nuanced understanding of the relationship between technology and education, prompting us to assess not only the potential benefits but also the unintended consequences and limitations associated with each wave of technological adoption (Collin & Brotcorne, 2019). In doing so, we can cultivate a more informed and balanced approach to leveraging technology for educational advancement. Yet, with use cases frequently driven by commercial interests or entities employing opaque development principles, many of these advancements have had, arguably, mixed results when it comes to transforming the learning experience or the prevailing pedagogy of the time. Certainly, the inclusion of personal computers, smart devices, and internet access in educational settings has felt important for a great number of students and educators, but to say that these technologies have radically altered how the

majority of students learn may well be looked upon decades from now as recency bias (Zhai et al., 2021). Rather, it might be more accurate to say that technology has served as a catalyst of sorts pushing stakeholders in the developed world to reconsider some teaching and learning processes, even while lacking the capacity required to fundamentally improve said processes. For example, while videoconference technologies have supported the rise of remote learning, the underlying teaching and learning experience remains largely uneven and, in some cases, has actually given rise to a host of new challenges requiring their own technological and pedagogical solutions. We see this in studies developed during the pandemic, where the issue of videoconference fatigue (Bennett et al., 2021) and technostress (Anh et al., 2023) were identified in both students and educators. Yet, even through this historical lens, the current levels of both promise and concern being afforded to AI and AI tools seems magnitudes greater than the introduction of earlier education technologies. In fact, Seldon et al. (2020) views AI as the Fourth Education Revolution considering a context in which AI is recognised by different authors as a lever of the Fourth Industrial Revolution (4IR). It is our hope that this book goes some way towards explaining how AI could serve as a powerful force for change within education, but more specifically, as a collaborative tool furthering the cause of human–AI creativity.

From Human Intelligence Emulation to Human–AI Creativity

The current hype surrounding AI may seem sudden, but in fact researchers have been building towards this moment since the 1950s. AI used to be the purview of researchers and science fiction authors living firmly in the realm of imagination. AI encompasses the emulation of human intelligence by machines or computer systems. It involves the development of algorithms and computational models that enable machines to perform tasks typically associated with human cognition, such as problem-solving, learning, and decision-making (Ng et al., 2023). AI systems leverage data and advanced algorithms to analyse

patterns, draw insights, and adapt their behaviour over time, aiming to replicate and augment human-like intelligence. This evolving field encompasses various subfields, including machine learning, natural language processing, and computer vision, contributing to the continuous refinement and expansion of AI capabilities. The ubiquitousness of generative AI tools and their ease of use has significantly altered the public perception around their usefulness. In recent years, a major disruption has emerged with the rise of generative AI and the availability of technologies such as Chat GPT, Midjourney, and AI chatbots and their relative ease of use. Today, AI can be found in any number of applications serving a diverse number of sectors and uses. From writing assistants to x-ray diagnostic tools to data processing, a significant percentage of the population has reportedly experimented with AI tools (Chui et al., 2023). Despite the current enthusiasm, there remains a considerable amount of work to be done around the risks associated with these tools. Questions of access, bias, data protection and privacy, use of copyrighted material in training models, and responsible use are growing louder as stakeholders struggle to keep pace with the rapid growth of AI use.

The traditional definitions of AI encompass a simulation paradigm in which artificial systems aim to replicate human systems. However, this approach does not consider its potential not only as human-like intelligence but as a cooperation tool for human–AI collaboration. Creativity is a complex human phenomenon that researchers try to replicate through artificial creativity systems. In education, considering creative pedagogy as a paradigm presents its own challenges given that there are no set methods explaining how to be creative; rather, strategies that facilitate the creative process (Pinillos & Vallverdú, 2021). This is supported by cognitive research showing creativity not as a construct of some novel process within the brain, but rather a combination of executive functions, neurochemical reactions and other mental processes (Beaty et al., 2018; Boccia et al., 2015). Given the lack of concrete instruction on how to be creative, how then should we consider the process of human creativity in relation to AI systems and associated concepts such as computational creativity?

For the international group of researchers contributing to this book, the answer lies in viewing the efforts of both systems as co-contributors with the shared goal of facilitating creativity—both as a function of process as well as ideation. As AI systems have become more prevalent and accessible, the relationship between humans and AI has evolved beyond process automation to a more collaborative partnership based on shared synergies and strengths (Razmerita et al., 2022) and the metacognitive potential of human–AI collaboration (Romero et al., 2023). It is at this intersection between human intuition and imagination and AI’s computation power and processing capabilities where we see the greatest potential for human–AI co-creativity. In fact, we can already see this potential today across a number of creative domains including music composition and performance (Rohrmeier, 2022) and in the visual arts where artists have leveraged AI tools to expand their creative process (Kim et al., 2021) through an extensive learning approach where AI serves transformational objectives (Romero et al., 2023). For our purposes though, it is the potential for revisiting creativity through the lens of human–AI interactions, innovative teaching strategies, and learner-centric activities that could support learners’ agency and a creative pedagogy supported by human–AI activities.

For facilitating the identification of the different levels of creative engagement in the use of AI, the Passive-Participatory (PP) model for AI in education (#PPai6) distinguishes six levels of creative engagement (Fig. 1.1).

At the first level, learners act as passive consumers, engaging with AI-generated content without a full understanding of its workings. Moving

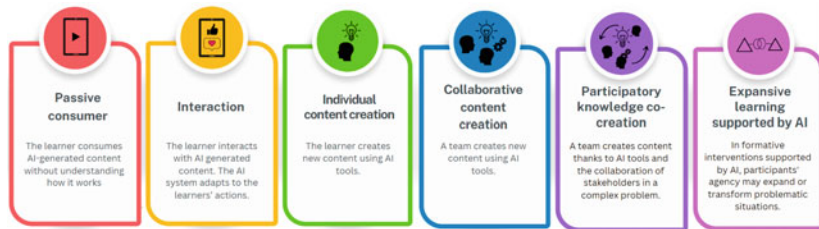


Fig. 1.1 Creative engagement in AI in education

through the levels, learners progress to become interactive consumers, actively interacting with AI-generated content as the AI system adapts to their actions. Levels three and four involve individual and collaborative content creation, respectively, with learners utilising AI tools to generate new content. The fifth level, participatory knowledge co-creation, sees teams creating content with the aid of AI tools and collaboration from stakeholders to tackle complex problems. At the sixth and most advanced level, expansive learning supported by AI, participants' agency expands or transforms problematic situations through formative interventions. AI tools play a crucial role in identifying contradictions in complex problems, generating concepts or artefacts to regulate conflicting stimuli, and fostering collective agency and action. While the potential for AI to reach this transformative level is immense, it is noteworthy that the majority of current AI in education studies operate at the second level (interactive consumer), primarily relying on Intelligent Tutoring Systems (ITS). The exploration of higher levels presents an exciting frontier for the future development and implementation of AI in education that will be explored through the different case studies of this book.

AI in Education, a Critical Domain for the Society

AI has emerged as a disruptive technology that holds the capacity to revolutionise certain educational endeavours, such as the composition of written essays or the facilitation of hybrid intelligence approaches (Järvelä et al., 2023; Molenaar, 2022). These hybrid systems, which amalgamate artificial and human intelligence, have the potential to enhance the pedagogical process by providing support for teaching and learning activities. AI, as a disruptive technology, possesses the capacity to revolutionise the process of knowledge creation for various educational stakeholders, including students, faculty members, and society as a whole. AI possesses the potential to not only be incorporated into hybrid systems designed to foster learners' agency and creativity, but also to facilitate the personalisation of the learning process. Through the utilisation

of sophisticated algorithms and extensive datasets, AI possesses the capability to facilitate the adaptability of digital educational environments, including educational serious games (Zhan et al., 2022). The primary objective of the individualised approach is to facilitate the active involvement of learners and offer tailored feedback that is contingent upon the specific nature of the learning tasks at hand. Though the use of learning analytics, AI technologies have the capability to facilitate the automation of administrative tasks, as well as detect and analyse potential challenges encountered by learners in their digital educational journeys.

Within the context of AI in education, much of the research has centred around institutional or strategic applications and AI in the practice of teaching and learning (Bates et al., 2020). Institutional applications primarily deal with data mining or AI's ability to organise huge data sets into relevant outcomes. This is particularly useful for helping educational institutions identify and diagnose systemic and individual problems within the current education framework (Zhai et al., 2021). The second approach, and the primary focus of this book, is how AI can enhance the learning experience by redefining current teaching strategies, expanding pathways for learning, and reducing or eliminating barriers to knowledge transfer. Specifically, the book explores the dynamic intersection of AI, education, and creativity, focusing on how human–AI learning activities can unleash creative pedagogies (Leroy & Romero, 2021; Lin, 2011; Selkrig & Keamy, 2017).

Education is not merely about imparting knowledge; it is about nurturing creative thinking, fostering critical skills, and empowering individuals to become lifelong learners. With the rapid advancement of AI, we are on the brink of a new era where intelligent technologies can enhance the learning experience in unprecedented ways, not only in relation to the personalisation of learning activities but to human–AI collaborations where AI supports the creative process of learners and teachers. In this context, we have the opportunity to redefine the boundaries of creative pedagogies by integrating AI into pedagogical practices at different educational levels and domains, thereby creating new opportunities for engaging, personalised, and transformative learning experiences through an expansive learning approach (Engeström & Sannino, 2021; Romero et al., 2023).

Through this book we aim not only to address the current practices of AI in education but also to develop further the opportunities and potentialities of co-creativity in human–AI technologies. The next section will introduce the organisation of the book towards these two main objectives.

The Organisation of the Book

This book focuses on the concept of creative application of AI in education as its central theme to address the pedagogical strategies for integrating AI in different educational settings ranging from primary to higher education, but also in outreach and citizen AI literacy activities. As such, the book is structured in three parts (Fig. 1.2).

1. The first part begins to develop the creative engagement perspective for learning and teaching AI, while describing how to use AI in creative ways through an expansive learning approach.
2. The second part of the book focuses on concrete examples of AI in K-12 education, not only from a researcher and teacher’s perspective, but giving learners the possibility to define their own vision, perspective,

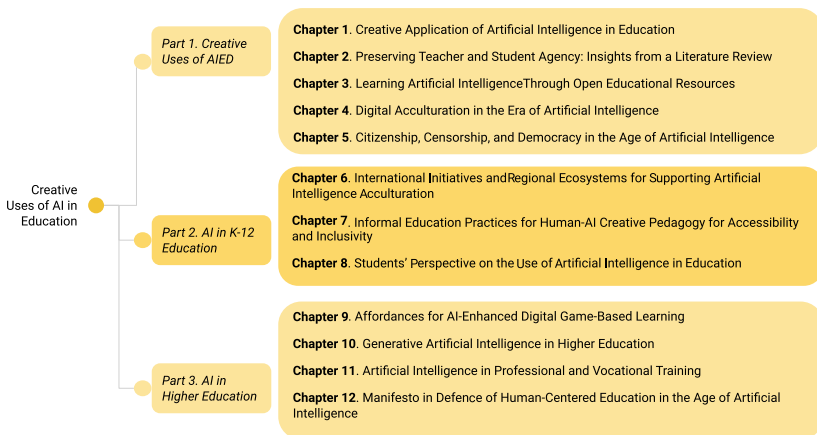


Fig. 1.2 Organisation of the chapters in three parts

doubts and worries related to the introduction of AI in education. These perspectives are important given that these learners will have a significant impact on our future society based on their relationships with these intelligent tools, established during their formative school years, and refined through their professional careers.

3. The third part of the book is devoted to the advances and opportunities of AI in higher education, covering not only different fields (e.g. teacher education, professional education, business education) but also different types of AI-supported tools such as games, chatbots, and AI assisted assessment.

Through these different activities, we propose concrete examples of how education could benefit from empowering all educational stakeholders in their AI literacy and their capacity to design human–AI learning activities that foster creativity, inspire critical thinking, and promote problem-solving by embracing AI as a tool for expansive learning.

The book also investigates the application of AI in various educational settings. From intelligent tutoring systems to adaptive game-based learning platforms, and from large language models such as ChatGPT to adaptive computer-supported collaborative learning (CSCL), we set out to analyse the various domains wherein AI can have a significant impact on enhancing the learning experience. Additionally, we examine how AI technologies can be integrated into both formal and informal education to empower educators, learners, and their communities, supporting co-creative human–AI activities and the development of transformative agency (Fig. 1.3).

The book “Creative Applications of Artificial Intelligence in Education” is both a roadmap and a catalyst for further exploration into human–AI co-creativity. It is a snapshot of our current position at the dawn of AI and educational synergies, but is also intended to encourage more multidisciplinary discussions around the benefits and potential challenges learners and educators face as we integrate and evolve this new relationship as co-creators. Join us then on this exciting and transformative journey as we investigate creative pedagogies and explore the integration of AI in education. Together, let’s develop and cultivate

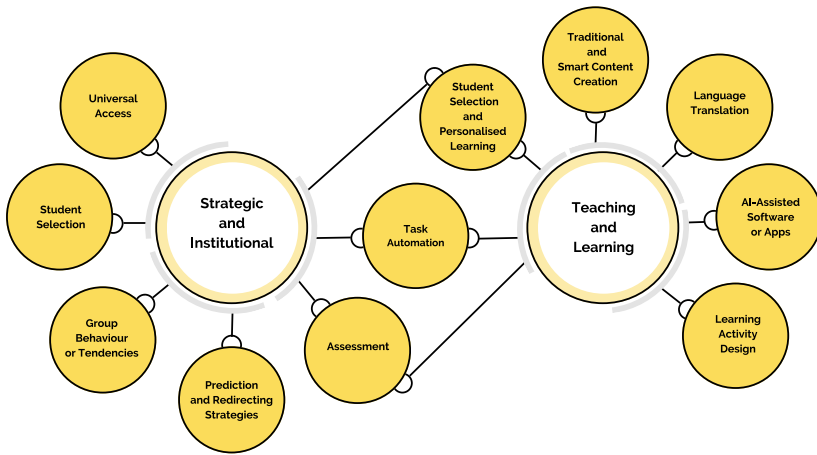


Fig. 1.3 AI application in educational settings

multiple perspectives on the impact of AI in education, harness its potential, and consider scenarios where human–AI collaboration can support learners seeking to creatively express their unique talents and develop expansive AI-supported learning initiatives.

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