Chapter 2
Unleashing the Potential: Positive Impacts of Generative AI on Learning and Teaching

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ABSTRACT

Generative artificial intelligence, anchored by large language models (LLMs), is significantly altering the educational landscape. This chapter examines the impact of generative AI on education, illustrating its capability to create personalized content and transform learning environments. Despite concerns over academic dishonesty facilitated by LLMs, the chapter argues against a regressive stance and advocates for the constructive integration of AI into educational practices. By drawing on theories of learning, the chapter elucidates the pedagogical implications of generative AI and describes specific use cases in language learning, computer science, and mathematics. Highlighting both the potential and limitations of this emerging technology, the chapter posits that generative AI is not merely a disruptive force, but a revolutionary tool poised to redefine the methodologies of teaching and learning.

1. INTRODUCTION

As the frontier of artificial intelligence (AI) continues to expand, one of its subfields, generative AI, is reshaping the educational landscape by producing engaging, personalized content and transforming learning environments. Large Language Models (LLMs) that underpin generative AI employ pattern matching to generate human-like text (Tang, Chuang, & Hu, 2023) represent the latest disruptive technology impacting society (Utterback, & Acee, 2005). In the past, many educators primarily relied on essays or extended answers from students to demonstrate content mastery (Farthing, Jones, & McPhee, 1998). However, with the advent of LLMs such as ChatGPT, less scrupulous students can simply input the question as a prompt and receive a grammatically perfect and coherent answer, albeit one that may contain factual errors (Malinka et al., 2023). Reactions of educational institutions to generative AI vary

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greatly: some have banned it, some have embraced it, while others remain undecided and leave the choice up to individual faculty (Kasneci, 2023). Previous disruptive technologies, such as calculators in mathematics, electronic dictionaries and machine translation in language learning, the internet across all subjects, are now widely accepted by educators. Considering the remarkable power of generative AI, adopting a luddite-like stance seems futile. Thus, this chapter argues in favor of embracing AI and empowering teachers and learners to utilize it effectively.

This chapter investigates the profound effects of generative AI on learning and teaching. Education is underpinned by theories of learning, which are described in relation to the pedagogic use of generative AI. Learning with AI and the creation of educational materials by AI are next addressed. Specific use cases related to language learning, computer science and mathematics education are described and discussed. Potential educational applications are then suggested. This chapter aims to provide a comprehensive understanding of the benefits of generative AI in educational settings while acknowledging its limitations. AI appears set to unleash a sea change in both the way that students learn and the way that teachers teach. Education, like most areas tends to improve incrementally, but we are now experiencing a radical innovation, which could be the harbinger of a new mode of education.

2. THEORIES OF LEARNING RELATING TO GENERATIVE AI

Teachers tend to draw eclectically from a range of techniques and strategies, often without explicitly adhering to a single underpinning theory (Moreira dos Santos, 2020). Individual teachers cultivate their own teaching philosophies, shaped by experience, context, and the unique needs of their students. These philosophies may be formally codified into a teaching philosophy statement or may be more nebulous and simply exist in the mind of the educator (Fitzmaurice & Coughlan, 2007). However, it is useful to understand the four main learning theories that have historically informed educational practices: behaviorism, cognitivism, constructivism and social constructivism (Adams, 2006; Bredo, 1997; Tomic, 1993).

2.1 Behaviourism and Cognitivism

Behaviorism was the dominant learning theory in the early to mid-20th century. Grounded in the work of psychologists like John B. Watson (Watson, 2017) and later B.F. Skinner (Todd, & Morris, 1995), behaviorism focuses on observable behaviors and the stimulus-response model where positive reinforcement leads to learning (Fisher, Piazza, & Roane, 2021). Cognitivism developed as a response to the limitations of behaviorism, shifting the focus from observable behaviors to the internal processes of the mind (Amsel, 1989). This learning theory postulates that understanding how information is received, processed, stored, and retrieved by the brain is essential for effective learning. Cognitivism provides a framework for examining how learners make sense of complex information, solve problems, and transfer knowledge, emphasizing the role of mental constructs like memory, perception, and attention in the learning process. Despite their differing perspectives on the nature of learning, behaviorism and cognitivism share some similarities, particularly in their systematic approaches to understanding learning processes. Both theories aim to develop structured methodologies for education, striving for predictability and control in learning outcomes. They both rely on empirical evidence and experimentation to validate their principles, leaning on the scientific method for credibility. Additionally, each theory places importance on the role of the environment in shaping either behavior or cognitive structures. Behavior-