The Role of Generative Artificial Intelligence in Promoting Creative Thinking Skills

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Abstract. In an era of rapid technological advancement, creative thinking has become crucial for mastering essential skills. Large language models like ChatGPT and GPT-4, developed by OpenAI, have revolutionized education by enhancing teaching efficiency, stimulating learners' creativity, and fostering critical skills. Generative artificial intelligence (GAI) shows significant promise in education but also presents challenges such as impacting traditional educational models and fostering technological dependency.

This paper explores GAI's dual impacts on cultivating creative thinking, both enhancing and potentially inhibiting it. Strategic recommendations will be proposed to maximize GAI's positive effects while minimizing its negatives, ensuring its healthy integration into education and talent development.

Keywords: Creative thinking; Generative Artificial Intelligence (GAI); ChatGPT; Artificial Intelligence; Higher Education.

1   Introduction

In the realm of educational advancement, generative artificial intelligence (GAI) has emerged as a transformative tool, particularly in its capacity to enhance creative thinking skills. Developed by leading AI innovators such as OpenAI, prominent models like ChatGPT and GPT-4 have revolutionized learning methodologies by introducing new paradigms in how information is delivered and processed. These dialogue-based systems not only optimize teaching efficiency and quality but also serve as catalysts for learner creativity and engagement, offering personalized learning experiences that adapt to individual needs.

However, the incorporation of GAI in education is not without its challenges. A key concern is that an overreliance on algorithmically generated outputs might inadvertently stifle originality, leading to a homogenization of creative expressions. This could result in a diminished capacity for students to develop unique ideas, as they may become more dependent on AI-generated content rather than fostering their independent creative thought processes. Moreover, the ethical implications surrounding GAI in education cannot be overlooked. Issues such as data privacy, algorithmic bias, and the

equitable distribution of AI-enhanced learning opportunities present significant challenges that need to be addressed to ensure that these technologies do not exacerbate existing inequalities or introduce new forms of discrimination.

This paper provides a critical analysis of the multifaceted effects of generative artificial intelligence on the development of creative thinking skills. It delves into how GAI both facilitates and potentially hinders creative thought processes, considering the complex interplay between AI-driven innovation and human cognitive development. The study aims to propose strategic frameworks that optimize the benefits of GAI while mitigating associated risks, ensuring that its integration into educational settings enhances, rather than diminishes, the creative capacities of learners. Through a nuanced analysis, this research contributes to the ongoing discourse on how AI technologies can be leveraged responsibly to foster innovation and creativity, ultimately shaping a future where technology and human ingenuity coexist harmoniously in the educational sphere.

2 What is Creative Thinking?

Creative thinking, essential for assessing individual creativity, involves synthesizing unique and valuable outcomes from prior experiences. This cognitive process encompasses divergent thinking, convergent thinking, insight, imagination, and creative analogical reasoning, with divergent and convergent thinking being central modes (Runco, 2003)[10]. Divergent thinking generates multiple solutions to open-ended problems, evident in tasks like concept expansion, story production, metaphor creation, and picture drawing, which emphasize originality and response fluency (Nijstad et al., 2010)[9]. In contrast, convergent thinking selects optimal solutions using existing knowledge and tools such as remote associates tests and insight problem-solving tasks.

In today's rapidly evolving technological and societal landscape, creativity is not only highly esteemed in research and practical applications but has also become an indispensable core element across various sectors. As artificial intelligence increasingly integrates into workplaces, the significance of creativity for managers, policymakers, and scholars has become ever more pronounced. Innovation is now a critical factor for business success, particularly in the digital age, where creativity and related meta-skills have gained heightened importance in both educational and professional spheres. The Organisation for Economic Co-operation and Development's (OECD) decision to include creativity assessments in the Programme for International Student Assessment (PISA) from 2022 onward further underscores the growing relevance of creativity in contemporary society and the global economy.

Creativity is not merely a key driver of individual competitive advantage in a constantly shifting, globalized world but also serves as a powerful engine for social progress and economic development. As such, it is imperative for all sectors to place greater emphasis on the cultivation and application of creativity. This focus will enable societies to address unforeseen challenges and maintain both competitiveness and innovative capacity in an increasingly complex and dynamic environment.

3   What is Generative Artificial Intelligence (GAI)?

GAI utilizes machine learning algorithms to produce original content, including text, images, and videos. This field emphasizes producing novel, high-quality content across multiple media formats including text, audio, and video, facilitated by deep learning methods and large-scale models with millions or billions of parameters (Chavan et al., 2024)[2]. These models demonstrate exceptional proficiency in tasks like text generation, language translation, and the production of creative content by adeptly identifying and reproducing complex data patterns and relationships.

Foundational models in GAI can be classified into three main types:

Large Language Models (LLMs), such as ChatGPT and Gemini, utilize Transformer architecture with parameter scales exceeding tens of billions for predicting word sequences and generating text. These models are pivotal in natural language processing tasks.

Computer Vision Models, including ResNet, EfficientNet, YOLO, Vision Transformer (ViT), and CLIP, are essential for visual perception in GAI, supporting tasks like image classification, object detection, and facial recognition.

Multimodal Models like CLIP, ViLBERT, MiniGPT-4, and PNP-VQA integrate visual, textual, and auditory data for tasks such as image captioning, text-to-image generation, and emotion recognition, surpassing single-modal models in flexibility and comprehensive understanding.

These advanced AI models drive innovation across industries and applications, serving as authoritative sources across media platforms and professions like customer service, writing, medicine, and education. Scholars, however, raise concerns about potential consequences such as cultural homogenization and the erosion of individuality amidst their transformative impact.

4   The Drawbacks of GAI

Limitation 1: Accuracy and Authenticity

GAI models, like ChatGPT, struggle with authenticity and creativity, generating outputs based on probabilistic combinations rather than true understanding or real-time context. This limitation leads to outputs that fluctuate between confidently accurate and nonsensically serious, hindering their reliability and predictability.

Limitation 2: Standardization in Language

AI language models tend to favor standardized language, lacking personalization and diversity across different cultural backgrounds and dialects. This results in generated content that lacks uniqueness and may not fully reflect cultural diversity (Gartner et al., 2024)[5]. The dominance of English in training datasets, such as with OpenAI's GPT-3, further exacerbates this issue, influencing the quality and diversity of generated outputs.

Limitation 3: Intellectual Property and Originality

The use of GAI raises complex issues regarding intellectual property rights, as models trained on existing data may inadvertently replicate copyrighted material. Questions

regarding ownership of AI-generated content are particularly contentious and have sparked legal and ethical debates.

Limitation 4: Critical Thinking and Creativity

Excessive dependence on generative artificial intelligence (GAI) tools may undermine the development of critical thinking and creativity among students and researchers (de Vasconcellos et al., 2021)[3]. The ease of obtaining solutions through AI may reduce motivation for independent research and problem-solving, impacting higher-order cognitive skills. Within academic and professional contexts, dependence on AI-generated outputs may erode individuals' abilities to think critically and independently.

These limitations underscore the significant challenges and ethical considerations associated with the widespread adoption of generative artificial intelligence (GAI) across various fields. The potential for unintended consequences, such as bias, misinformation, and loss of human agency, necessitates a careful and comprehensive evaluation of GAI's applications. Moreover, the rapid advancement of GAI technologies calls for robust regulatory frameworks to ensure that their deployment aligns with ethical standards and societal values. By addressing these concerns proactively, we can mitigate potential risks while maximizing the benefits that GAI offers, fostering innovation that is both responsible and equitable.

5   How to Use GAI to Enhance Creativity

In spite of potential drawbacks, appropriately guided use of GAI tools significantly enhances critical thinking and creativity among students and professionals. Essel et al. (2024)[4] demonstrated that ChatGPT positively influenced critical, reflective, and creative thinking skills among undergraduate students in Ghana. Yilmaz and Yilmaz (2023)[11] similarly observed enhanced performance in computational thinking, programming self-efficacy, and motivation among students using ChatGPT in programming education. GAI's role as an impartial collaborator that supports learners in exploring ideas through questioning and reflection, benefiting fields like healthcare by reducing reliance on direct "trial and error" with patients. In the era of information technology, research increasingly focuses on maintaining and enhancing critical thinking and creativity through GAI applications.

6   Using GAI to Cultivate Creative Thinking

Wallas (1962)[6] conceptualized creative thinking as a dynamic and multifaceted process that involves a range of psychological activities and cognitive strategies. He introduced the four-stage model of the creative process, which systematically categorizes creative thinking into distinct phases: **Preparation, Incubation, Illumination, and Verification** (see Figure 1).
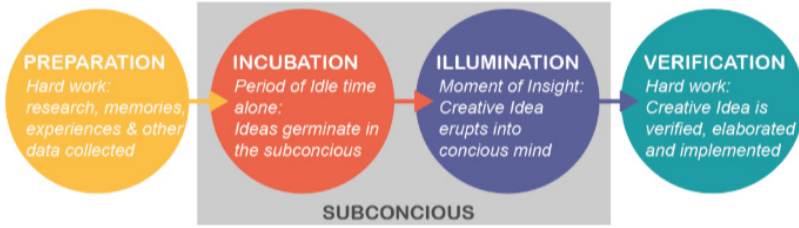
Fig. 1. The Wallas Model of the Creative Process

Guilford (1950)[7] critiqued the four-stage model of creativity, arguing it superficially addresses creativity without delving into its specific psychological processes. Aithal and Silver (2023)[1] proposed integrating AI into teaching critical thinking skills through a three-step method: understanding and analyzing ideas, evaluating them, and applying acquired knowledge to problem-solving.

Building on Wallas's four-stage model and insights from Aithal and Silver (2023) [1], this study constructs a framework to enhance critical thinking and creativity using GAI:

Preparation: Participants gather relevant information via extensive research and collaborate with AI chatbots, though AI's limitations necessitate ongoing human oversight to mitigate errors and biases. Methods include cross-verifying AI outputs with reliable sources, applying background knowledge, and continuously refining AI algorithms.

Incubation: During this stage, individuals divert focus from the problem, allowing subconscious processing. Collaboration with AI can stimulate ideation by offering diverse perspectives and questions.

Illumination: The stage where subconscious insights surface consciously, facilitating creative problem-solving. GAI aids in generating unique solutions and conducting simulated experiments.

Verification: Rigorous evaluation of insights gained in the Illumination stage ensures their feasibility and effectiveness. Robust assessments are crucial before adopting GAI outputs, necessitating benchmarks and empirical validation.

This structured approach ensures GAI enhances creativity and critical thinking effectively, addressing potential biases and errors through rigorous evaluation.

7   Conclusion

Amid the transformative impact of the Fourth Industrial Revolution, artificial intelligence (AI) is swiftly reshaping societal and economic structures. While AI demonstrates exceptional capabilities across a multitude of domains, it encounters significant challenges in emulating the nuanced and inherently human trait of creativity. In this rapidly evolving landscape, the 4C skills—Collaboration, Creativity, Critical Thinking, and Communication—emerge as crucial competencies for individuals to effectively navigate and succeed. The cultivation of these skills, which remain elusive for AI to

master, is vital for maintaining future competitiveness, encompassing essential attributes such as digital fluency, resilience, and adaptability (McNeilly, 2023)[8].

Given the growing reliance on AI across various sectors, it is crucial for research to explore how generative artificial intelligence (GAI) can be harnessed to enhance creativity education. GAI's ability to simulate complex real-world scenarios offers opportunities to improve analytical thinking, problem-solving, and communication skills through collaborative learning that embraces diverse perspectives. Embedding these critical 4C skills into educational frameworks and professional training programs will better equip individuals to navigate the unpredictable challenges of the Fourth Industrial Revolution. As technological advancements continue to accelerate, human creativity remains an irreplaceable asset, essential for driving innovation and ensuring sustainable progress. Therefore, nurturing these uniquely human skills alongside AI capabilities is vital for preparing for a future where human ingenuity and machine intelligence coexist harmoniously.

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