Human-Centred AI in Education in the Age of Generative AI Tools

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Abstract

Artificial intelligence (AI) based on machine learning, neural networks, and large language models has created an enormous interest during the past year, peaking with the release of ChatGPT (GPT 3.5) at the end of 2022. The educational sector has been in turmoil as knowledge acquisition, effective teaching, and meaningful learning experiences are its foundational building blocks. In the following position paper, we explore how human-centered AI (HCAI) can be a useful perspective on AI in the age of generative AI (GAI) for the educational sector. However, we also suggest taking advantage of GAI tools to prepare the next generation of students for a future workplace requiring informed interaction with AI tools. We argue there is a lot of potential for applying AI in education, which can be advantageous for both teachers and students to increase the educational experience. However, there are also major challenges. For example, GAI tools do not yet align with learning theories that promote student agency during knowledge construction (e.g., constructivist learning theories).

Keywords

Agency, Artificial intelligence (AI), AI in education, ChatGPT, education, generative AI, human-centred AI, scaffolding, sociocultural learning

1. Introduction

Artificial intelligence (AI) as a tool has transformed many sectors of society, including healthcare, finance, agriculture, and education. After the introduction of ChatGPT, AI as a concept has extended its reach from technophiles to the public, ranging from skeptics to enthusiasts. There are several definitions of AI with slightly different angles. One provided by ChatGPT is as follows: "Artificial Intelligence (AI) refers to the ability of machines to perform tasks that would normally require human intelligence, such as learning, problem-solving, decision-making, and natural language processing. AI is achieved using algorithms and statistical models that enable machines to learn from data, recognize patterns, and make predictions." [1] Educational systems around the world aim to learn more about how to apply AI in meaningful ways and steer away from the challenges. The challenges include lack of (or little) human interaction by favoring algorithms, negative impact on student agency (more auto-generated text than student produced text), and privacy issues (student data used by third parties); the opportunities include personalized learning, student assessment, and educational content creation (e.g., automatically generated lesson plans).

We argue in this position paper for the evolution of AI to HCAI by turning AI around to intelligence augmentation (IA). Shneiderman [2] underscores that the goal in HCAI is to put human users at the center stage, emphasizing user experience design, measuring human performance, and celebrating the new powers that people have. HCAI is an approach to the design and development of AI systems that prioritizes the needs, abilities, and experiences of human users. The goal of human-centered AI is to create AI systems that are transparent, trustworthy, and accountable, and that enhance human capabilities and well-being [3]. HCAI enables developers to build and design AI systems that support

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human self-efficacy, promote creativity, distribute responsibility, and facilitate social participation [2], which are human abilities that align with educational goals [4]. To achieve HCAI goals, we highlight the crucial role of human interaction as an enabling condition. We illustrate this through various contrasting examples and propose new research questions specifically tailored for workshop discussions. An example to illustrate the contrast between generative AI (GAI) and HCAI in education is text composition (e.g., essay writing), a basic skill taught in school. A GAI tool for text production creates text automatically based on user input (prompt), whereas an HCAI tool provides automated feedback (output prompt) based on user-composed text [5]. In this position paper we contrast HCAI and GAI of visual and textual artifacts and explore how AI generative tools may impact education, research, and theory.

2. Background

2.1. Generative AI tools: Strengths and limitations

Generative AI refers to a type of artificial intelligence that can create new content, such as images, videos, music, and text, which is not based on pre-existing examples or data. GAI tools use different types of algorithms to learn the underlying patterns and structure of the data, and generate new content based on these structures. The algorithms focus on different aspects of the generative AI process such as: transformer architecture, pre-training on large data sets, fine tuning for specific tasks, natural language processing (NLP), and deep learning [6].

Generative AI can be used in a broad range of activities, for example in medicine and health care, from creating synthetic medical images for training, to generating patient-specific treatment plans and recommendations, to organizing administrative activities [7]. In the field of AI-generated art, GAI tools such as DALL-E have been used to create original music and paintings that are indistinguishable from those produced by human artists [8]. However, generative AI also raises ethical and legal concerns related to intellectual property, privacy, and accountability. For example, the use of generative AI to create videos and images for spreading misinformation and propaganda, poses a significant threat to democracy and public safety. Despite these challenges, generative AI continues to advance at a rapid pace, with new research and applications being developed in various fields [9].

Our preliminary observations have highlighted a notable dilemma with the current generation of GAI tools: while they excel in capturing intricate details, they fall short in embodying emotions and meaning—both crucial human values [8]. In this paper, we delve into this discrepancy by addressing three key challenges. Firstly, we explore the intricacies of representing parts and wholes (relations) in artifacts. Secondly, we examine the complex nature of artifacts created by humans, which involve multiple levels of abstraction during the creative process. Finally, we consider the superior performance of human interaction with GAI tools as highlighted by computer science scholar Wegner [10]. To bridge the gap and tackle these challenges, we propose a distinction between two approaches to integrating parts and wholes in artifacts. The algorithmic logic employed by GAI tools represents one method, while the interactional logic of human development represents another. The algorithmic approach, unlike the interactional one, fails to consider intermediate-level abstractions that are inherent to human development and evident in conversations, written compositions, and image understanding. These intermediate-level abstractions are closely linked to interaction, meaning, and emotions—elements of human concern that computers overlook when algorithms completely automate artifact creation [11]. To illustrate this point, we present two examples.

Consider the production of literature references by GPT 3.5. At the lowest level, a reference is composed of a sequence of words, which serves as the primary unit of analysis for the machine learning algorithm. However, at a higher level, where human experts operate, the words are organized into meaningful units, or aggregated components, referred to as intermediate building blocks such as Authors, Title, Journal, and URL. Although GPT 3.5 may accurately reproduce each of these components, the resulting artifact—a bibliographic entry—often turns out to be incorrect or nonsensical, despite initially sounding plausible. This same dilemma is evident in images generated by visual GAI tools like DALL-E. Each visual part of an image may be a flawless rendition of a specific artwork piece, but when these parts are assembled within a broader context, they fail to convey coherence or elicit an emotional response (Figure 1). Some proponents of AI tools argue that such

outcomes represent a unique creative aspect, while others view them as limitations of data-driven machine learning. ChatGPT offers the following explanation: “Fixing this issue is challenging, as: (1) during reinforcement learning (RL) training, there’s currently no source of truth; (2) training the model to be more cautious causes it to decline questions that it can answer correctly; and (3) supervised training misleads the model because the ideal answer depends on what the model knows, rather than what the human demonstrator knows.” [12].

Figure 1: Two automated renderings of Johannes Vermeer's “Girl with a Pearl” by August Kamp. *Left*: The main image reproduces the original Dutch painting. *Right:* The same image is placed in a reconstructed scene that creatively modifies the original meaning. However, this modification flattens or smoothens the emotional response [13]. We argue that adopting a socio-cultural perspective and an interactional approach will enhance the learning experience by enabling a human-centered interpretation of the context

2.2. Human-centred artificial intelligence

Shneiderman [2] believes human-centered AI (HCAI) can help design AI systems that support human creativity, clarify responsibility, and facilitate social participation. To achieve this, HCAI should consider the following: 1) a two-dimensional HCAI framework with high levels of both human control and automation, 2) a shift to empowering people with tool-like applications, and 3) a governance structure for more reliable AI systems [2]. Fischer [14] suggests end-user development (EUD) and AI should integrate and that HCAI intersects with EUD in areas like IA, explainable AI (XAI), ethics and trust, and shared understanding. Yang and colleagues [15] argue that AI can evolve into HCAI by considering human conditions and contexts and developing AI technology that can enable different forms of human performance. HCAI can be used in education with tools such as AI-enabled chatbots, smart content, and intelligent assessment, among others.

However, there are challenges and opportunities for K-12 education in implementing AI. Akinwalere and Ivanov [16] present examples of introducing AI in higher education, discussing its possibilities and risks. Andersen, Mørch & Litherland [17] provide an opportunity for HCAI with an AI chatbot to provide automated feedback to offload domain-specific scaffolding from teachers to computers in makerspace classrooms. The scaffolding is based on rules that test relations between design units of a makerspace (software and hardware components) to provide instructional feedback [17]. The feedback consists of only a few number of words, which is one of the characteristics that distinguish HCAI and GAI. Scaffolding by HCAI aims to help students become independent learners and therefore operates in the background, foregrounding student’s work.

2.3. Learning theories

A critical role of HCAI with respect to GAI is to preserve context and make sure humans are kept in the loop during transformation, which is the process of turning sequential input data, such as natural

language prompts, to generate output (text and images) based on machine learning models. This process is not in outset compatible with human learning theories, advocating agency, and social context, i.e., constructivist learning theories.

Constructivism is a theory originating more than 100 years ago that puts forward the hypothesis that knowledge is not passively received but actively built on an individual's prior experiences [18]. It also considers the main function of cognition as adaptive to organize and make sense of the experiential world [19-21]. Social constructivism, a branch of constructivism, emphasizes social context and facilitation (instruction and scaffolding). This approach originated with Vygotsky [22] and is often referred to as sociocultural learning theory, which is the approach adopted in our research. Student agency is a central tenet when studying learning from a constructivist perspective, as it emphasizes that learners should have control over their own learning and be active participants in the construction of their own knowledge. Unfortunately, this feature is at odds with the current generation of GAI tools. The students are not able to control the knowledge construction process when interacting with these tools solely by input prompts, which is one of the main reasons for the current controversy in the education sector caused by ChatGPT and related tools.

3. A new research agenda

3.1. Position statement and research questions

Our statement in this position paper is that generative AI tools (GAI) (such as ChatGPT) provide numerous possibilities for enriching the educational sector both for teachers and students. However, some dilemmas exist that require further research: GAI tools provide detailed information about many topics, but it is not personalized to the student or teacher, which limits the learning experience. As mentioned in the previous section, the context generated by GAI tools are creative and explore new meanings rather than aiming to preserve original (e.g., historical, or cultural) meaning. The latter is more attuned to learning from a sociocultural perspective by emphasizing how a learning process always is situated in a social practice and contextualized in a cultural tradition. Therefore, in further research it could be interesting to explore how GAI tools can take the socio-cultural context of the learners more into consideration when interacting with the learner to generate new information. One scenario could be that instead of the GAI tools asking for textual input, the GAI tools could ask the learner to provide a description or picture of the context the learners have in mind to provide more meaningful and personalized output, which may enrich the learning situation for the parties involved.

Research questions from this perspective include:

- How can future advancements in GAI tools incorporate the social context and learner background to enhance their functionality and effectiveness?
- In what ways can the interaction with GAI tools be conceptualized as a contextualized learning process, fostering personalized dialogues that stimulate deep learning?
- If the challenges in the first two RQs prove to be difficult for data-driven machine learning, what approaches can be employed to integrate "truth models" associated with specific domains of knowledge and expertise into GAI tools?

Another crucial avenue for further research lies in exploring the conceptual foundations of learning with GAI tools. Human learning is a multifaceted system characterized by various levels of abstraction and interactions between subsystems, and it necessitates careful consideration when it comes to interaction with GAI tools. Building upon prior work in HCAI, there is a need to examine the role of human interaction in complex learning systems involving AI tools, particularly in the education sector. This investigation can shed light on the concept of human-computer complementarity, determining the tasks at which computers excel and those that are best performed by human learners. Furthermore, it is worthwhile to reflect on how GAI tools can enhance user-adapted output by incorporating new sources of information. For instance, the GAI may request specific details from the user to customize the response, such as inquiring about their learning goals or the context in which the answer is required. By effectively leveraging this information and actively contributing to the construction of a more dynamic context, the GAI tool can be regarded as a partner in the interactional learning process. From this perspective, some research questions to explore include:

- What are the optimal roles for computers and humans in the process of learning with GAI tools?

- How can LLM GAI tools generate instructional feedback and personalize the learning experience?
- Should there be a word limit imposed on LLM GAI tools' output to provide automated scaffolding of human generated text, rather than generating lengthy responses?
- How can the use of input prompts in successive steps facilitate the development of shared meaning (intersubjectivity) between humans and GAI tools, transcending their role as mere inputs to the AI system, while avoiding a sole focus on knowledge?
- How can GAI tools be effectively integrated into collaborative learning scenarios within virtual worlds and other online learning communities (e.g., metaverse), such as role-playing games and mass collaboration platforms?

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