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EDITORIAL

Collaboration of Generative AI and Human: Paradigm Shift for Higher Education

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Similar to transformative inventions like the steam engine, electricity, computers, and the internet throughout history, artificial intelligence (AI) is evolving into a general-purpose technology, rapidly reshaping every aspect of human society. Unlike previous technological inventions that have improved human beings' ability to interact with the environment from the perspective of mechanized enhancement, the emergence of AI has challenged the fundamentals of human beings. AI has not only profoundly transformed the capacity and role of humans in engaging with their surroundings but has also emerged as a pivotal technology driving a new wave of scientific and technological revolution, as well as industrial transformation. It has a significant and far-reaching impact on economic development, social progress, global political and economic patterns, and educational reform.

In the field of education, AI is revolutionizing teaching and learning models centered on the accumulation and transfer of knowledge, especially that generative AI (GenAI) could create novel content and innovative solutions same as our human being. GenAI can be used to inspire and foster creativity, lend multiple perspectives, summarize existing materials, generate and reinforce lesson plans. For instance, when students compose prompts for large language models (LLMs), they are, in essence, engaging in a creative process. This activity necessitates that students envision possibilities beyond the immediate horizon, navigate through conceptual explorations, and anticipate potential outcomes—precisely the types of creative skills that educational programs aim to cultivate.

For academic research, GenAI is being increasingly integrated into scientific discovery to augment and accelerate research, helping scientists to craft a unique and promising research hypotheses, design experiments, visualize and interpret large datasets, and gain insights that might not have been possible using traditional scientific methods alone.

We contend that the harmonious integration of GenAI with learners and educators can effectively harness the respective strengths of both entities, thereby optimizing the attainment of educational objectives. Working together, a Human–GenAI paradigm can achieve better learning outcomes than either one working alone. Unlike traditional approaches where technology merely augments human efforts, human–AI synergy denotes a seamless integration where AI complements and enhances human capabilities, and vice versa.

This special issue comprises 10 articles, categorized into the following four directions:

First, **model development and technical frameworks**, focusing on the development, optimization of LLMs, and innovations in cognitive diagnostic methods. Liu et al. (2025b) introduces CELLM, an open-source LLM tailored for Chinese education, providing foundational benchmarks for pretraining and instruction-tuning. Meanwhile, Ma et al. (2025) propose a zero-shot cross-domain cognitive diagnosis framework leveraging LLMs to address data scarcity in educational assessment. Dong et al. (2025) further advances cognitive diagnosis by integrating LLMs with the SOLO taxonomy, enhancing accuracy in identifying student competencies. These contributions underscore the potential of LLMs to democratize educational tools and improve diagnostic precision.

Second, **educational applications and evaluations**, which exploring the practical applications and effectiveness assessments of LLMs in both K-12 and higher education. The analysis of Zhu et al. (2025) on large foundational models in K-12 education highlights their role in resource recommendation, content generation, and automated grading, while proposing actionable strategies for scalable implementation. The

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MathEval benchmark in Liu et al. (2025a) systematically evaluates LLMs' mathematical reasoning capabilities, offering educators a practical tool for selecting and refining models. Study of Krause et al. (2025) on GenAI's impact on higher education combines surveys and scenario analyses to propose solutions for integrating AI into teaching and learning workflows.

Third, **personalized learning and student profiling**, which investigate how to utilize GenAI to construct student profiles and promote personalized learning. Tu et al. (2025) focus on AI-empowered personalized learning identifies technical mechanisms and ethical challenges, advocating for sustainable and equitable educational practices. Li et al. (2025) demonstrate how student profiling via knowledge graphs can drive data-driven instructional design, supported by multimodal datasets. These studies emphasize the need for adaptive systems that cater to diverse learner needs.

Forth, **discussion on the impact of DeepSeek on education**. Wang (2025) exemplifies broader discussions on balancing AI's transformative potential with cultural and pedagogical values. Wu (2025)'s commentary on DeepSeek explores the impact of this open-source large model and delves into the practical approaches in education.

The future of education lies not in choosing between AI and human teachers, but in embracing the powerful potential of their collaboration. By combining the analytical power of AI with the irreplaceable human element of teaching, we can truly transform education into a new paradigm for the next generation.

However, it is also important to note that realizing the collaboration of GenAI–human in education requires thoughtful integration, ethical consideration, and ongoing research and development efforts to address technical, pedagogical and societal challenges.

Conflict of Interest Fei Wu is a member of the Editorial Board of *Frontiers of Digital Education*, and Jingyuan Chen is a Senior Editor of *Frontiers of Digital Education*. They were excluded from the peer-review process and all editorial decisions related to the acceptance and publication of this article. Peer-review was handled independently by the other editors to minimise bias.

Data Availability Statements The authors confirm that all data generated or analysed during this study are included in this published article.

Authors Contributions Fei Wu contributed to the writing of the original draft. Jingyuan Chen finished material preparation and revised the manuscript. All authors whose names appear on the submission made substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data; or the creation of new software used in the work; drafted the work or revised it critically for important intellectual content; approved the version to be published; and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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