

Guest Editorial: Human-centered AI in Education: Augment Human Intelligence with Machine Intelligence

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ABSTRACT: This special issue focus on underlying research with the use of human-centered AI (Artificial Intelligence), where the new design methods and tools can be leveraged and evaluated, hopes to advance AI research, education, policy, and practice to improve the human condition in education. This special issue intends to advocate an in-depth dialogue between researchers with diverse thoughts, genders, ethnicity, and cultures, as well as across disciplines, leading to a better understanding of human-centered AI. Beneficial interactions between researchers could enhance the adoption of human-centered AI in education. This special issue includes ten papers demonstrating how to augment human intelligence with machine intelligence. The ten papers feature human-centered AI in education, AI in language education, AI in learning analytics, ethical reasoning, AI in the clinical workplace, intelligent education robots, AI risk framework, intelligent course recommendation, education chatbots, and intelligent assessment. Together with the ten papers, we achieve a better understanding of the application of human-centered AI in education.

Keywords: Human-centered AI, AI in education, Humanity, Sustainable education, Future learning

1. Introduction of human-centered AI in education

As we strive to develop AI technology, we also need to reflect appropriately on the impact of social change on education. How do we provide fair and explainable analysis results to gain learners' and teachers' trust? How do we guide learners and teachers to meet challenges from both technical and organizational aspects? How do we consider technological development with social value and work towards sustainable education and future learning?

The advance of AI in decision-making, prediction, knowledge extraction, and logic reasoning has been making a broader impact on society, the economy, and the environment (Luan et al., 2020; Yang et al., 2021). AI has the potential to educate, train, and augment human productivity, making them better at their tasks and activities. AI can also make the better quality of an individual's work, resulting in better learning and teaching. Human-centered AI can be interpreted from two perspectives (Yang, 2021; Yang et al., 2021), one is AI under human control as addressed by Shneiderman (2020), and the other is AI concerning the human condition defined by Stanford HAI (2022). AI under human control is to leverage the collaboration between human control and AI automation to empower human productivity with high reliability, safety, and trust. AI concerning the human condition is that AI algorithms taking humanity as the primary consideration, require explainable and interpretable computation and judgment process, and continuously adjust AI algorithms through human context and societal phenomena to augment human intelligence with machine intelligence, thereby enhancing the welfare of human kinds.

The shifting of AI research trends has brought new applications of AI in education. One example of transfer intelligence is the generation and adoption of new deep learning algorithms with pre-trained knowledge datasets in natural language processing, such as BERT with 340M dataset mentioned in Devlin et al. (2018), GPT-3 with 175B dataset in Brown et al. (2020), and Megatron-Turing NLG with 530B dataset in Smith et al. (2022). They apply pre-trained knowledge to fine-tune domains and be more effective than the previous generation of deep learning and traditional machine learning algorithms. These new algorithms can achieve performance that is closer to humans. In addition, the promise of precision education commits to applying AI research to intelligent tutoring for precise adaption and personalization, precise profiling, diagnosis, prediction, treatment, and prevention for smart assessment and evaluation as mentioned in Yang et al. (2022).

In addition, potential ethical issues are involved as AI requires a large amount of learner data, sometimes sensitive information for model training. The data collection process must obtain the consent of the students and teachers in the first place, and the management and storage of data must meet the requirements of data security and the protection of personal privacy to make AI educational systems theoretically and educationally sound.

2. Human-centered AI toward sustainable education

Sustainable education is a quality education considering humanity. The challenge for sustainable education is incorporating cultural and social changes into the design from the outset, including educating all stakeholders and providing the appropriate training. To develop the most helpful strategies for stakeholders from different perspectives, such as the content, methods, tools, and platforms for education and training.

The theme of human-centered AI toward sustainable education includes ethical issues of fairness and equality, explainable and trustworthiness; social issues of diversity and inclusion, resilience and robustness; governance issues of accountability, data safety, adaptation, and accessibility.

AI could be misused because of biases in data and algorithms. Analytic algorithms trained on regular articles will learn and reproduce the societal biases against women and minorities, which are embedded in languages and culture. Word embedding is an example, it is a popular technique in natural language processing has been found to exacerbate existing gender and racial stereotypes. Fairness and equality means that the analysis technology must produce unbiased and fair results. The analysis process should not include discrimination and unfair analysis results against race, religion, gender, and physical disability. We can avoid bias of data/algorithms by understanding cultural and social impact on education, and by designing bias detection and prevention algorithms in the pre-processing, in-processing, and post-processing of AI model training.

Human-centered AI must have sufficient interpretability, and the current algorithms are inadequate in this regard. Explainability provides a certain degree of transparency and explanation in the decision-making process. Explain the process of reaching conclusions and adjusting the transparency of data and algorithms according to the differences of stakeholders. Trust comes with accuracy, transparency, explainable, and fairness. This decision-making process requires complete explanations to gain trust and avoid unnecessary negative consequences. Therefore, explainable and trustworthy AI is necessary to enable explanation and comprehension so humans can understand how AI makes decisions. Researchers are working on explainable algorithms, hoping they can explain the reasons for each decision to increase the trustworthiness when making complex decisions.

Inclusion is based on diversity, equity, and belonging. Inclusive education breaks down systemic barriers to inclusion. It fosters a culture where every learner knows their belonging, feels empowered to bring their whole self to learning, and is inspired to learn. When we face sudden and dramatic changes in our living and educational environment, resilience reflects how we can recover from natural disasters or disease pandemics like COVID-19. Resilience education includes the technical robustness and safety of networks and devices, accessibility of teachers, and adaptation and accessibility of content, tools, and platforms.

With human-centered AI considering fairness, equality, inclusion, diversity, explainability, trustworthiness, and resilience, we can work together toward sustainable education.

3. Contribution of papers to this special issue

Ten papers have been included in this special issue. They address how to achieve the goal of human-centered AI in education and why their proposed system and method are better while considering humanity. Papers in this special issue inspire future studies of human-centered AI and conclude the finding in their study based on analyzing data collected from experiments or a systematic review. The ten papers feature human-centered AI in education, AI in language education, AI in learning analytics, ethical reasoning, AI in the clinical workplace, Intelligent education robots, risk framework, intelligent course recommendation, education chatbots, and intelligent assessment, together to achieve a better understanding of the application of human-centered AI in education. The following is the list of papers' titles and authors.

Title: Unpacking the “Black Box” of AI in Education,
Authors: Nabeel Gillani, Rebecca Eynon, Catherine Chiabaut, and Kelsey Finkel

Title: Trends, Research Issues, and Applications of Artificial Intelligence in Language Education
Authors: Xinyi Huang, Di Zou, Gary Cheng, Xieling Chen, and Haoran Xie

Title: A Learning Analytics Framework Based on Human-Centered Artificial Intelligence for Identifying the Optimal Learning Strategy to Intervene in Learning Behavior
Authors: Fuzheng Zhao, Gi-Zen Liu, Juan Zhou, and Chengjiu Yin

Title: A Human-Centric Automated Essay Scoring and Feedback System for the Development of Ethical Reasoning

Authors: Alwyn Vwen Yen Lee, Andrés Carlos Luco, and Seng Chee Tan

Title: Feasibility and Accessibility of Human-centered AI-based Simulation System for Improving the Occupational Safety of Clinical Workplace

Authors: Pin-Hsuan Wang, Anna YuQing Huang, Yen-Hsun Huang, Ying-Ying Yang, Jiing-Feng Lirng, Tzu-Hao Li, Ming-Chih Hou, Chen-Huan Chen, Albert ChihChieh Yang, Chi-Hung Lin, and Wayne Huey-Herng Sheu

Title: Artificial Intelligent Robots for Precision Education: A Topic Modeling-Based Bibliometric Analysis

Authors: Xieling Chen, Gary Cheng, Di Zou, Baichang Zhong, and Haoran Xie

Title: A Risk Framework for Human-centered Artificial Intelligence in Education: Based on Literature Review and Delphi–AHP Method

Authors: Shijin Li and Xiaoqing Gu

Title: AI, Please Help Me Choose a Course: Building a Personalized Hybrid Course Recommendation System to Assist Students in Choosing Courses Adaptively

Authors: Hui-Tzu Chang, Chia-Yu Lin, Wei-Bin Jheng, Shih-Hsu Chen, Hsien-Hua Wu, Fang-Ching Tseng, and Li-Chun Wang

Title: Effects of Incorporating an Expert Decision-making Mechanism into Chatbots on Students' Achievement, Enjoyment, and Anxiety

Authors: Ting-Chia Hsu, Hsiu-Ling Huang, Gwo-Jen Hwang, and Mu-sheng Chen

Title: Application of Artificial Intelligence Techniques in Analysis and Assessment of Digital Competence in University Courses

Authors: Tzu-Chi Yang

4. Conclusion and future research

Modern learning technologies need to be more accurate and intelligent to help students formulate practical learning guidance and intervention. We envision that future learning will closely rely on some fundamental learning technologies, such as smart learning analytics, precision education, and human-centered AI.

Smart learning analytics is a research field with the optimal goal of improving learning and teaching by building better pedagogies, empowering active learning, targeting at-risk students, providing intervention, and assessing student success. The goal is to improve teachers' teaching quality and students' learning outcomes. Research on smart learning analytics is needed to improve the quality of teaching (i.e., teachers must identify and address topics of concern to students, such as inadequate feedback from learning environments), identify which students are struggling with a particular topic, and understand how their content has been used and how effective it is. Smart learning analytics enables teachers to continually enhance educational content to be tailored to students' level of understanding as they progress and monitor student's performance so that teachers can adapt their teaching. Smart learning analytics enables students to take control of their learning, know how they are performing compared with peers, and complete assessments to keep up with the learning progress of their peer group and helps teachers identify gaps in students' prerequisite knowledge and key study skills.

Precision education is to discover students' differences and individual characteristics and guide students to conduct individualized learning accordingly. Teachers can make preventive adjustments to students' critical behaviors. Based on the student's learning status, learning ability, and other relevant individual characteristics, promptly carry out individualized remedial activities. Precision education is the best opportunity to achieve individualization and turn personalized learning from one-size-fits-all to one-of-a-kind. Precision education is to identify at-risk students as early as possible and provide them with timely intervention through diagnosis, prediction, treatment, and prevention. To be more specific, precision education's process diagnoses students' engagement, learning patterns, and behavior. Making predictions concerning students' learning performance and improving predictive models, followed by treatment with learning strategy and activities through timely intervention and prevention. Through precision education, teachers can understand students' learning situations by diagnostic system, extract data and establish a learning prediction model, then design adaptive learning

activities for different types of students with one-of-a-kind treatment and prevention. The challenge ahead is how to accurately establish student and data models so that teachers can better understand students' differences to generate individualization. Establishing a student model involves whether the acquisition of student data is ethical, whether the evaluation of learning outcomes is objective and fair, and whether the student model's establishment is open and transparent.

Future learning is a process of unlearn and relearn to foster student-centered learning. Teachers need to reimagine the future world, unlearn the lecture-oriented teaching method and relearn the human-centered technology to guide students to reimagine the future world. Teachers must also relearn modern learning technology and change from teaching to guiding students to conduct individualized, self-regulated, autonomous, and seamless learning. There are no magic pills in education, like rehabilitation in medical; good teaching needs well-designed strategies and practices. Strategies are diversified, and the value of teachers, like the value of coaches, lies in knowing how to apply learning activities and teaching methods wisely. With the research of smart learning analytics, precision education, and human-centered AI, we envision a pathway toward sustainable education in the future.

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