# Human-Centric Teaching at Scale in Online Education through Bidirectional Feedback in Human-AI Interaction

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### Abstract

In online education, the nature of information presents a significant challenge. The crux of the problem is that for effective transfer of knowledge in the absence of context and non-verbal communication, meaning must be communicated in the language itself. In this work, we outline the roles that human and AI can fill to address this gap with social and technical approaches in the individual, classroom, and organizational levels of human-AI interaction. We aim to stimulate dialogue on roles in human-AI collaboration that prioritize human social norms in the design of sociotechnical systems which lead to the preservation of human-centric values.

### Introduction

In online education, the nature of information presents a significant challenge (Amoah and Le Roux 2024). The crux of the problem is that for effective transfer of knowledge in the absence of context and non-verbal communication, meaning must be communicated in the language itself (Taft, Perkowski, and Martin 2011). This issue is amplified by that fact that broadcasting is the preferred teaching strategy in MOOCs, characterized by one-way communication of course content to a large classroom (Gillani et al. 2014), in contrast to one-on-one mentorship which was the primary form of pedagogy in ancient times.

# **Key Challenges**

As a parallel evolution of teaching, *Temnothorax albipennis* ants display the first known example of teaching in a nonhuman animal in tandem running, where a teacher ant know the location of food but the student ant does not. The tandem leader waits for the student and only continues when frequently tapped by the following ant's antennae. Their patterns of acceleration and deceleration based on their stimuli to each other has been suggested to be a form of bidirectional feedback (Franks and Richardson 2006). An insight that can be drawn from this example is that bidirectional feedback is a social norm that can occur with simple stimuli, given that the information is valuable to the teacher and student. In humans, an analogy can be drawn between tandem running in ants to the apprenticeship model, based in mentor-mentee

relationships. One relevant adaptation in online education is the cognitive apprenticeship model, which focuses on teaching students critical thinking and metacognitive processes by giving examples of expert thinking (Collins, Brown, and Newman 1989).

For the problem of the scale of online classrooms, conversational AI can automatically answer many routine questions, and offers a possible solution for a natural way for students to engage in one-on-one dialogue like how they would with a peer or a tutor in a physical classroom (Chaudhry and Debi 2024; Labadze, Grigolia, and Machaidze 2023; Taneja et al. 2024). In the absence of context, AI may overcome the absence of non-verbal communication by capturing meaning from language at a superhuman level (Navarro 2022; Wang et al. 2021). Given the difficulty of achieving consistent and uniform interpretation across all listeners through natural language, AI can act as a translator for the speaker's message, tailoring the message to each listener so that the original intent of the speaker is clearly understood.

Personalization is a process that can facilitate this translation. Dialogue can be tailored to the individual during interactions between AI and student, and for the teacher, information be personalized such that it is relevant and intuitive to the teacher (Yanez et al. 2024). Personalization in human-AI collaboration aims to provide both the right level of perception, and the right level of exposition. Visualizations in a common interface between instructional staff can help with filtering and aggregating individualized student data to obtain classroom level insights (Goel et al. 2024). Keeping the human-in-the loop allows teachers to learn from the information, which can improve their own practice, guide instructional design, or to give transferable insights for their parallel work. In-line with the tandem running example in ants, a potential for AI recommendation for teaching are highimpact examples, tailored for the classroom's needs and bypassing the necessity for direct interaction, but still grounded in bidirectional feedback. Loosely speaking, AI can help teachers speak through their actions and lead by example.

### **Human-AI** Collaboration

As for how to keep the human in the loop, research in the community of inquiry (CoI) framework has shown the effectiveness of teaching in small communities (Fiock Brown 2020; Lowenthal et al. 2019; Setlhako 2019;

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Taft, Perkowski, and Martin 2011). With the basis that mentors do not necessarily need to be teachers, AI can act as a matchmaker, suggesting groupings and organizing the larger community into small communities which are effective for learning at little cost to the teacher, while teacher assistants (TA)s and advanced students can take on mentoring and leadership roles (Setlhako 2019).

Human-AI collaboration is a sociotechnical problem. A potential human solution is bidirectional feedback (Myers and Chou 2016), and a potential technical solution is personalization. In online classrooms with AI, personalization and bidirectional feedback enable each other, fostering a human-centric learning experience (Junus et al. 2019). We aim to enrich information for teachers at the individual, classroom, and organizational level to achieve bidirectional feedback between teacher and student, regardless of class size. Tandem running ants have suggested that it is the value of information, not intelligence, that has driven the evolution of teaching. With the information they have available, they have found a way to teach effectively in large societies and thrive through adopting the social norm of bidirectional feedback. By personalizing information, we reduce the crux of the problem faced in online education to a similar one solved by tandem running ants. Through integrating bidirectional feedback into the DNA of human-AI interaction, teaching can evolve in a way that is human-centric and nurturing to us.

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