

Building Ladder: Leveraging Knowledge Building Principles to Foster Interaction Between Human and Generative AI

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Abstract: This DBR study (n=33) explored human-AI collaborative patterns and how teacher-GAI collaboration can be optimized for knowledge building in STEAM teaching designs. The results indicated (1) four categories of human-AI collaboration: Operator-Supplier, Apprentice-Mentor, Ally-Ally and Agent-Producer. (2) Constructive use of GAI with community-based principle facilitated teachers' knowledge building on prompting strategies and intention, making collaboration between teachers a conducive design principle to prove more productive interaction between teachers and GAI in the teaching design. (3) Implications for human-AI interactions are discussed.

Introduction

The integration of Generative artificial intelligence (GAI) into daily life mandates its inclusion in teachers' professional development (TPD) (Mishra et al., 2023). However, the unclear interaction definition within humans and GAI threatens learning agency and the thinking depth (Lee et al., 2023; UNESCO, 2023). The empirical evidence suggests that ChatGPT's impact on cognitive skills remains unsure (Essien et al., 2024), but the development for strategic knowledge under GAI would stabilize the positive impact from ChatGPT (Søberg & Chaudhuri, 2018; Essien et al., 2024). To explore a sustainable ecological learning environment, Tan et al. (2023) and Teo & Tan (2023) suggested an AI-supportive models in education. However, the models discuss little about teachers' and teacher community's collaboration with GAI. This neglect was proved to threaten agency (Sætra, 2023). Therefore, the purpose of this study is to examine two questions: 1) how teachers may work with GAI naturally without much support or guidance? 2) how to design effective guidance to foster productive teacher-AI collaboration?

Participants and data recourse

Participants were 33 in-service teachers at a university in Taiwan. Data were collected from participants' (1) online discussion in Knowledge Forum (KF); (2) oral report during the class. A reflective question was employed in the oral reports: "what have you learnt from using ChatGPT?" All data were coded as the format: I (Individual)/G (Group); R (reflective journal)/O (Oral report); E/L(Stage); C (Cycle); P (Participant); 01 (Participant code) (e.g., "IR-C2EP14" represents an individual reflective journal in earlier stage from Cycle 2, written by Participant 14).

Research design

The study followed McKenney & Reeves' (2021) model for design-based research (DBR). The participants spent 3 hours per week for 18 weeks completing a STEAM teaching design. Two design cycles were employed: Cycle 1 included 18 teachers in 6 groups while Cycle 2 included 15 teachers in 6 groups. There were two stages in each iteration. The earlier stage included designing 1) theme/objective 2) activity / question 3) teaching design; later stage included 1) synthesizing ideas to revise teaching design 2) present final teaching design. As the later stage focused on higher cognitive work, we expected participants to display a more intentional and adaptive strategy to collaborate with ChatGPT.

At the beginning, participants had few ideas and experience about working with ChatGPT in teaching design. Therefore, in Cycle 1, participants were focusing on the application of GAI-generated responses. As a result, teachers mostly focused on the less-productive relational patterns and lacked engagement with GAI-use strategies in instructional design. Therefore, we built Cycle 2 a "community" element on the Cycle 1 design. The focus of Cycle 2 was on develop shared strategies for engaging with GAI, such as sharing how to refine and give prompts to ChatGPT. The main design difference of two iterations was that Cycle 2 focused on practical experience with ChatGPT.

Data analysis

This study applies three layers of analysis. First, a content analysis was conducted to code the categories of interaction. 103 pieces of meaningful paragraph were used to analysis. The interaction traits were coded for each paragraph in the initial coding. Codes were grouped by semantics into focused code, and refined through discussions with a second researcher, achieving a Cohen's Kappa .76. Second, nonparametric test was conducted to assess whether the design principle fostered effective interaction through stages. Third, a study of case 21 was select by GAI using experience to illustrate how community principles integrating with GAI could benefit to all teacher, even to the experienced GAI user.

Result

Cycle 1: Human-AI interaction in constructive use of GAI (CUG)

In cycle 1, four interactions were found: (1) Operator-Supplier: ChatGPT as a search engine or text generator excludes any support or interaction with participants. (2) Apprentice-Mentor: ChatGPT as the mentor to provide support or feedback to guide the discourse. The emphasis is on participants' transmitted learning during the interaction. (3) Ally – Ally: participants and ChatGPT is on the equal status and the inspiring interaction between each other. (4) Agent – Producer: the participant domains idea-improving conversations. ChatGPT conducts low-level work enabling learners to spend time on higher-order thinking, being the agent of improvable ideas.

Descriptive statistics indicated that four interactions were extracted in across Cycle 1. Nonparametric test indicated no significance of four categories, but the frequency that low-level Operator-Supplier decreased from 37% to 18%, high-level Ally-Ally increased from 29% to 38%, and Agent-Producer also increased from 29% to 32%.

The finding suggests that (1) teacher-GAI collaboration showed four major types to support different tasks in teaching design (2) the agency of working on the ideas through GAI under constructively using was inadequately approach to the productive interaction, cycle 2 was needed to refine design principle.

Cycle 2: Intervention of community principle in human-AI collaboration

In Cycle 2, four patterns also appeared across two stages, four interactions were confirmed. Nonparametric test indicated Agent-Producer notably increased ($z = -2.008^*$, $p < .05$). It echoed the practice of cycle 2's design principle that participants demonstrated and explained the intention behind their prompts to spark further exploration while they were using ChatGPT. In other words, when principle-CUG meet community, it combined artificial intelligence and collaborative intelligence to support teacher's agency.

Finally, a case study from case 21 shows the human-AI interaction from isolated use of GAI to the collaboratively used GAI. The changes of case 21 includes teaching design ideas, knowledge working mindset, and awareness during ChatGPT usage. Since case 21 was an experienced ChatGPT user, a shift displayed the possibility that higher-level participant was also benefit from collaboratively GAI use.

The finding suggests that (1) collective discussion supported participants clarify the interactive role and seek better constructive actions, (2) community-based principle is beneficial to Human-GAI interaction for facilitating humans as an epistemic agent.

Significance of the study

First, the roles in the study are aligned with prior discussions in classrooms (Chen & Tsai, 2021; Ji et al., 2023). Yet, prior discussions were more to single aspect of GAI's function or teachers' intention. As such, we explored principles and bidirectional definition to foster a productive human-AI collaboration. The result of principle refine is similar to "symmetric knowledge advancement" (SKA) in Knowledge Building theory (Scardamalia, 2002). Moreover, the interactions' strategies and intention differ (Chen & Tsai, 2021), it reflects the importance of teachers' choice of the appropriate GAI-interaction (Teo & Tan, 2023).

Second, the findings provide language to help users develop (1) meta-level of strategy-, self-regulated-thinking (2) agency-level of transform the class into more creative/collaborative knowledge workers. Given the above, teachers should utilize community support while/in teaching design, so that human-AI process could be more meaningful to create sustainably improvable teaching design ideas as well as resilient scaffold for students.

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