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Supporting Preservice Teachers' Responsive Teaching in Artificial Intelligence-integrated Simulations

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Abstract: This mixed-methods study explored how preservice teachers (PSTs) practiced responsive teaching in an AI-integrated teaching simulation. Twenty PSTs practiced teaching with AI students in virtual world-supported participatory simulations. Data triangulated from dialogue transcripts, observations, and interviews indicated that AI-integrated participatory simulations enabled authentic, analytical, and reflective learning experiences that empowered PSTs to attend to students' ideas. Moreover, virtual students bring nascent resources as productive beginnings of reasoning that PSTs can build on.

Introduction

Preparing preservice teachers (PSTs) to enact responsive teaching, practices of which students' disciplinary thinking and reasoning are the building blocks of the scientific inquiry process, is a key goal for teacher preparation (Hammer et al., 2012). However, despite the growing interests, many PSTs find it challenging to recognize students' disciplinary ideas and manage the tension between pursuing students' ideas and attaining learning objectives. These challenges underscore the need for developing effective teacher training interventions that improve responsive teaching skills for PSTs.

Researchers suggested adopting participatory simulations to provide a contextualized and experiential learning experience (Ke et al., 2020). Participatory simulations are the imitative representation of the essential elements and structure of a system, which enable preservice teachers to practice pedagogical problem solving and approximation of teaching skills, and have been advocated to be a promising supplement to teacher education programs (Ke et al., 2020). Additionally, the need for adaptive learning and personalized support gave rise to the research on artificial intelligence-based (AI) learning in teacher education. Specifically, the implementation of virtual students can simulate natural language dialogues between teachers and students in participatory simulations, prompting PSTs to attend to the substance of students' epistemic thinking and reasoning, and guide students in productive learning (Dai et al., 2021; Dai et al., 2024; Ke et al., 2020). However, little research has been conducted to explore the design and impact of AI-integrated simulations in supporting PSTs' practice of responsive teaching. This study is part of a larger research project that explores how to support PSTs' responsive teaching practices in participatory simulations with AI students. Specifically, we ask the following research questions: 1) *what are PSTs' responsive teaching patterns in AI-powered participatory simulations?* 2) *how did the simulations with AI students support high leverage practices?*

Method

This mixed methods case study aimed to uncover the responsive teaching patterns enacted by PSTs in AI-integrated teaching simulation. The simulated science classroom was designed and deployed in OpenSimulator, a virtual world platform. Virtual students are driven by an AI-powered student model that is built with a generative Large Language Model (GPT) from OpenAI, further trained/customized with a representative dataset of science-math classroom interactions, and then layered with a student trait-state model that is inferred from both classroom datasets and the research literature on traits, states, and situations of learning. Twenty PSTs voluntarily participated in the study. Each participant attended a 2-hour session individually to practice teaching with AI students and complete an interview. The sessions were screen recorded. The data were collected and triangulated from in-simulation dialogue transcripts, observations, and semi-structured interviews. A total of 1361 teacher talk moves were logged in the form of in-simulation dialogue transcripts. Two researchers coded 30% of the talk moves between participants and AI students based on responsive teaching principles to establish the coding framework and reached complete agreement. The rest of the transcripts were coded independently. For the quantitative data, we employed association rule mining to uncover PSTs' responsive teaching patterns and reported the measures of support, confidence, and lift. For the qualitative component, we leveraged thematic analysis to provide insights into how AI-integrated simulations facilitated PSTs' responsive teaching practices.

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Results

Sequential analysis

Table 1 summarizes preservice teachers' frequent teaching patterns in the simulation. One of the most prominent (support >.1, lift >1.2) patterns was {revoice => connect}, where preservice teachers synthesized student ideas and uptook those ideas as a whole class activity. Preservice teachers purposefully employed different strategies to elicit students' ideas. For example, in {follow up => question modification}, after follow-up questions, participants modified the questions, either by simplifying or rephrasing, to encourage diverse contribution. Participants were also able to notice the alternative explanations or misconceptions, and employ responsive talk moves to build consensus. For example, in {attend to misconceptions => connect}, preservice teachers attended to the misconceptions by orchestrating dialogues and inviting peer students in group discussion.

Table 1

Sequential patterns of responsive teaching

Teaching patterns	Support	Confidence	Lift
revoice => connect	.13	.62	1.44
follow up => question modification	.13	.18	1.23
attend to misconceptions => connect	.02	.25	3.46

Qualitative analysis

Thematic analysis revealed that AI-integrated participatory simulations enabled authentic and practice-based learning experiences with ample opportunities to enact microteaching. As P9 mentioned, "*It really helped me practice the talk moves in a very explicit way.*" Participants were empowered to notice and interpret student thinking in the '*low-stake*' learning setting, as P8 noticed, "*I stop and think about my next move, which might not be possible in the real life.*" P17 also reflected as she noticed evidence in student thinking, "*She [AI student] got confused near the end, and that's when she stopped understanding.*" Moreover, AI students can simulate authentic classroom dialogues that are semantically and functionally meaningful, providing naturalistic stimuli and feedback to prompt participants to respond to the nuances in student thinking, as indicated by P19's comment, "*Maybe this is too hard of a question [I asked].*" PSTs' mention of such noticing helped them take a reflective and adaptive stance, "*I'm questioning myself that how I can ask different questions to make connections* (P8)."

Discussion and implication

The findings indicated that preservice teachers were able to enact high-leverage talk moves that center teaching on students' thinking. The participatory simulation deployed in the study affords a low-stake and authentic environment for preservice teachers to interpret students' ideas and practice responsive teaching acts, key components to facilitate student-centered knowledge construction. Moreover, virtual students can bring nascent resources as productive beginnings of reasoning for preservice teachers to orchestrate discussions and respond to students' needs (Hammer et al., 2012). The findings of this study provided preliminary evidence for the prospects of using AI-powered participatory simulations in teacher preparation (Dai et al., 2021).

References

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