

Characterizing preservice teachers' mathematical conversations with large language models (LLMs) through the lens of responsive teaching: The case of guiding an LLM out of error

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Abstract

The rapid adoption of large language models (LLMs) in educational settings has created a new reality in which teachers and preservice teachers engage in mathematical and pedagogical dialogue with widely available AI systems. Despite the pedagogical potential attributed to these tools, there is still no systematic, research-based understanding of their capacity to support the development of core mathematics teaching practices, nor of the design principles such development requires.

This study focuses on interactions between preservice mathematics teachers and LLMs around one of the most demanding practices in mathematics teaching: helping students move beyond errors through their own mathematical reasoning. In instructional interactions with students, and in line with the principles of Mathematically Responsive Teaching (MRT), this practice requires teachers not only to identify and explicitly address errors, but also to treat students' mathematical thinking as a resource for advancing understanding.

Here, we examine how preservice teachers guided LLMs out of mathematical errors during a course activity in which they were asked to challenge the models with a mathematical problem and then support them in correcting their reasoning—that is, to lead the model toward a valid solution. To this end, we analyzed 20 conversations between preservice teachers and LLMs using discourse-analytic tools and characterized the responsive features of these exchanges. Our analysis draws on Systemic Functional Linguistics (SFL), a linguistic framework that enabled us to operationalize mathematical responsiveness.

The findings reveal substantial variation in responsiveness across preservice teachers and show that responsiveness can develop dynamically within a single conversation. The study makes a twofold contribution: methodologically and theoretically, it develops the MRT-SFL tool for analyzing mathematical responsiveness in interactions with artificial intelligence (AI) models; and pedagogically, it demonstrates that dialogue with LLMs, under certain design conditions, can serve as a productive platform for developing responsive mathematics teaching.

Keywords: Large Language Models (LLMs); mathematically responsive teaching; guiding out of errors; teacher education; Systemic Functional Linguistics (SFL).



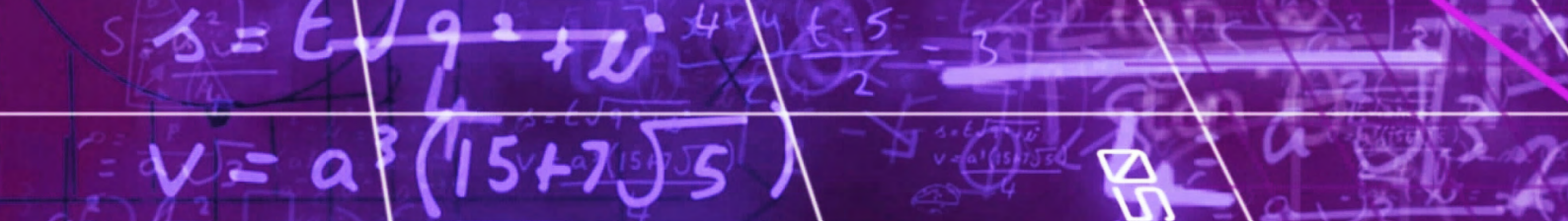
Characterizing the dialogue between mathematics teachers and generative ai while designing geometric inquiry tasks integrating dynamic technologies and its contribution to teachers' TPACK

Ruti Segal and Anat Klemer

Abstract

This study examined the characteristics of the dialogue between teachers and generative artificial intelligence (GenAI) during the planning of geometry lessons integrating dynamic technological environments and their contribution to teachers' Technological Pedagogical Content Knowledge (TPACK). In a qualitatively dominant mixed-methods case study, three primary-school mathematics teachers used Claude to plan lessons combining GeoGebra and Origametry. Data included transcripts of dialogues with Claude, recordings of Curiosity Driven Discourse (CDD), collaborative research journals, and TPACK questionnaires. Quantitative analysis of pre- and post-course questionnaires was combined with qualitative-interpretive analysis of the transcripts and journals, using the constant comparative method. Findings revealed two main dialogue characteristics: an iterative dialogue for refining prompts and a dialogue encouraging critical thinking. The dialogue contributed to all TPACK components, including deeper geometric understanding, varied teaching strategies, and improved technological skills. CDD emerged as an accelerator of learning, while highlighting the need for professional judgment regarding GenAI outputs.

Keywords: Technological Pedagogical Content Knowledge (TPACK); dynamic geometry; generative artificial intelligence (GenAI); mathematics education; teachers' professional development; Curiosity Driven Discourse (CDD).



Integrating a chatbot into pedagogical instruction during the training of high school mathematics teachers

Sigal Cohen Toledno and Orit Broza

Abstract

Lesson planning in mathematics is considered a central challenge in teacher education, particularly in addressing learner heterogeneity, fostering higher-order thinking, and promoting effective mathematical discourse. Despite the growing potential of AI-based chatbots in instructional planning, the discourse that develops between pre-service teachers and a dedicated chatbot has not yet been thoroughly examined, especially regarding how this discourse reflects dimensions of didactical suitability according to the onto-semiotic approach.

This design-based research examines how the discourse of six pre-service teachers with a chatbot constitutes a dialogic space for planning high school mathematics lessons. Using the onto-semiotic approach, two planning processes with the chatbot were analyzed for each participant. Six dimensions of didactical suitability were examined: epistemic, cognitive, mediational, interactional, affective, and ecological. The findings indicate consistent engagement with epistemic and cognitive dimensions across both interactions for all participants. Notable development was observed in the second planning process regarding students' difficulties, the co-construction of knowledge, the expansion of representational diversity, and the promotion of learner autonomy. In contrast, mathematical discourse and differentiated instruction remained limited, despite the chatbot's guidance on these aspects. These findings demonstrate that AI-based chatbots may serve as a professional learning space that supports the deepening of pedagogical-didactical knowledge and the development of reflective planning. Furthermore, the findings highlight the potential of integrating chatbot use with human pedagogical mentoring namely, creating a critical dialogic space between a pedagogical mentor and pre-service teachers around AI-supported lesson planning, with a focus on the students' decision-making processes when using the chatbot.

Keywords: artificial intelligence in education; mathematics teacher education; lesson planning; onto-semiotic approach; dedicated chatbot.



Between ready-made solutions and independent thinking: Preservice mathematics teachers' guided use of ai in solving solid geometry problems

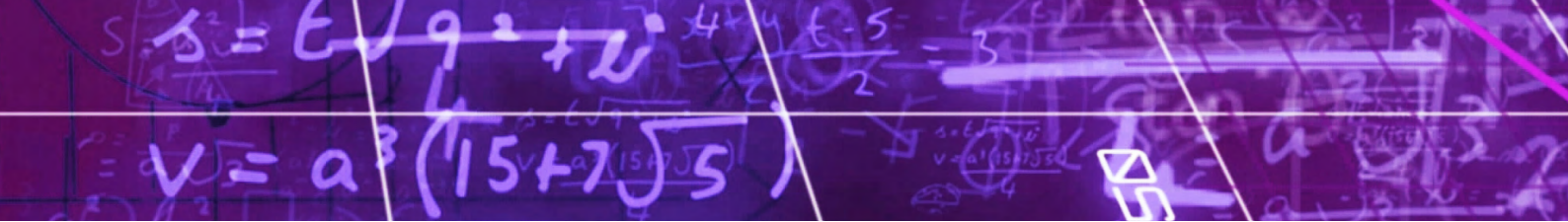
Nelly Keller and Galit Nagari Hadif

Abstract

The expanding use of generative artificial intelligence (Generative Artificial Intelligence; GenAI) raises a central pedagogical question for mathematics education: Does artificial intelligence (AI) replace learners' independent thinking, or can it support such thinking when its use is guided and controlled? This study examines how guidelines for the guided use of artificial intelligence shape the ways in which preservice mathematics teachers engage with high-cognitive-demand problems in solid geometry. The study was conducted in the context of a course on solid geometry. Sixteen preservice teachers participated in the study, working on three problems that addressed the angle between a line and a plane, the angle between skew lines, and the distance between skew lines. For each problem, the participants were required to formulate an independent initial position, engage in a guided dialogue with artificial intelligence, present a final solution, and write a reflection. The data consisted of 48 work processes, which were analyzed through qualitative content analysis using an interpretive approach.

The findings indicate that the structure of the task helped preserve the students' position as problem solvers and encouraged conceptual clarification, requests for justification, validation checking, and reservations regarding unsatisfactory responses. Two moves were particularly salient: identifying an implicit geometric assumption in the pyramid problem, and moving from visual intuition to formal justification in the problem concerning the distance between skew lines. The findings suggest that mathematical AI literacy is not limited to the technical skill of using a tool, but relies on mathematical proficiency, particularly conceptual understanding, reasoning, and monitoring. These findings have implications for mathematics teacher education, as they highlight the importance of developing mathematical AI literacy grounded in judgment, reasoning, and monitoring, rather than merely in the technical use of the tool.

Keywords: guided use of artificial intelligence (AI); solid geometry; mathematical proficiency; mathematical AI literacy; high-cognitive-demand tasks.



The considerations guiding secondary mathematics pre-service teachers in rejecting ChatGPT suggestions during mathematical problem posing dialogues and the development of their pedagogical autonomy

Ruti Segal and Yaniv Biton

Abstract

This study forms part of a broader research project investigating mathematical problem posing supported by generative artificial intelligence (ChatGPT). It focuses on a phenomenon that has received limited attention in the literature: the reasoned rejection of AI-generated suggestions. This focus is grounded in the assumption that moments of rejection, rather than acceptance alone, provide a unique window into pre-service teachers' professional judgment, pedagogical content knowledge, and educational beliefs. Accordingly, the study aims to characterize the considerations underlying the rejection of ChatGPT's suggestions and to examine how these interactions contribute to the development of pedagogical autonomy in the emerging context of human–AI collaboration. The participants were fifteen pre-service secondary mathematics teachers enrolled in a specialized teacher education program. Each participant was asked to design two mathematical problems and iteratively refine them through a dialogue with ChatGPT. A notable finding from the broader study revealed that 11 of the 24 documented dialogue episodes (46%) included an explicit rejection of at least some of ChatGPT's suggestions. This finding indicates that rejection is not a marginal phenomenon but rather a meaningful pattern that warrants investigation as a research focus in its own right.

The findings identify three distinct patterns of considerations guiding participants' decisions to reject ChatGPT's suggestions and demonstrate how engaging in critical dialogue with AI contributes to the development of pedagogical autonomy, enabling future teachers to exercise independent professional judgment while using generative AI as a pedagogical partner rather than as an unquestioned authority.

Keywords: pre-service mathematics teachers; mathematical problem posing; generative artificial intelligence (GenAI); ChatGPT; pedagogical autonomy.



Data-based instruction in mathematics among teachers using a personalized adaptive learning environment

Ruti Berger Baraban (of blessed memory), Michal Ayalon and Yaniv Biton

Abstract

This study was conducted against the backdrop of the growing international emphasis on data-based decision-making (DBDM) and data-informed instructional planning in mathematics education. Over the past decades, educational systems have increasingly adopted data-driven approaches to improve instruction and optimize the alignment of teaching with students' learning needs, particularly in mathematics. The study extends current knowledge by examining mathematics teachers' decision-making processes based on assessment data generated by an adaptive learning system and by characterizing the pathways that guide instructional intervention decisions.

The study investigated the decision-making processes of five experienced elementary mathematics teachers using My Way (Fractions My Way), an innovative adaptive learning environment developed by the Center for Educational Technology (CET) to support the teaching of fractions in Grades 4–5. All participants had more than 15 years of teaching experience and at least three years of experience using the adaptive system. Data were collected through semi-structured interviews and non-participant classroom observations.

The findings identified three distinct decision-making pathways: (1) a partial direct pathway, involving only some of the decision-making milestones; (2) a complete direct pathway, progressing sequentially through all milestones; and (3) an iterative pathway, characterized by repeated returns to earlier milestones to obtain additional information before making instructional decisions.

The iterative pathway demonstrated the most effective use of assessment data, whereas the direct pathways reflected a more basic level of data utilization. The findings provide valuable insights for decision-makers in mathematics education and for designers of adaptive digital learning environments. Moreover, the study highlights the potential of adaptive learning systems to strengthen teachers' data-based instructional decision-making and enhance formative assessment practices.

Keywords: data-based decision making (DBDM); adaptive learning environment; decision-making pathways; formative assessment; learning dashboard.