Research/Empirical

"Let's Ask the Robot!": Epistemic Stance Between Teacher Candidates Toward AI in Mathematics Lesson Planning

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Abstract

Generative artificial intelligence (AI)-powered conversation agents such as ChatGPT are increasingly being used in teacher education. Although ChatGPT can provide ample resources for lesson planning, little attention has been paid to how teacher candidates construct prompts and evaluate AI-generated outputs in real time to develop lesson plans. Taking up Bisconti et al.'s conceptualization of generative AI as a social agent in a sociotechnical system, this article investigates how knowledge construction is dynamic and negotiated through interaction when using ChatGPT to develop lesson plans. We applied conversation analysis through Heritage's gradient model of epistemic stance—which captures moment-to-moment expressions of social relationships—to analyze how teacher candidates position their knowledge in relation to that acquired from ChatGPT, as managed through their prompts and questions. Our findings aim to offer insights to help teacher educators develop scaffolds for teacher candidates to critically curate content from AI-powered agents and identify areas needing further instructional support.

Keywords

artificial intelligence, ChatGPT, human–artificial intelligence collaboration, lesson planning, mathematics teacher education, sociotechnical systems, epistemic stance, social agents

Introduction

In teacher education programs, lesson planning is regarded as a core practice in teaching where teachers develop skills to support student learning (John, 2006; Lee et al., 2016). Yet, developing lesson plans can be challenging due to the complexities of teaching (John, 2006; Kang, 2017; Lee et al., 2016). Research has shown that teacher candidates make use of multiple resources (e.g., online websites, university faculty, and cooperating teachers) and amass ideas when developing a lesson plan (Sawyer et al., 2020). However, it is rare for teacher candidates to critically consider the processes of searching for information, evaluating validity, and identifying possible biases (Sawyer et al., 2020). Furthermore, they may not explicitly reference, change, tinker, or remix lesson ideas that were inspired by the collection process. Such findings indicate that teacher candidates require support to become more proficient in lesson planning so they can critically curate and create content, rather than simply consume information passively.

Recent advancements in generative artificial intelligence (AI)-powered conversation agents allow real-time dialogues between users and chatbots, offering potential as a collaborative lesson planning partner (Sabzalieva & Valentini, 2023). AI-powered conversation agents, such as OpenAI's ChatGPT, Google's Gemini, and Microsoft's CoPilot, possess large volumes of information that can be valuable resources for lesson planning. With natural language processing techniques, AI-powered conversation agents analyze user input (e.g., questions) and generate human-like responses (Lee & Yeo, 2022). The impact of AI-powered conversation agents has been powerful and divisive. Some challenges and ethical implications include academic integrity that may arise when students use ChatGPT, content authorship and ownership, production and dissemination of content that discriminates or reinforces gendered, racialized, and other forms of bias, and the unequal distribution of environmental impacts, such as excessive energy and freshwater use (Flavin & Flavin, 2024; Sabzalieva & Valentini, 2023). Although co-existing with these concerns, the use of AI in education has continued to expand.

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Recent literature on the applications of AI-powered conversational agents in lesson planning reported that teachers do not passively accept the information generated by AI-powered conversational agents (Corp & Revelle, 2023), a contrast to the work by Sawyer et al. (2020). Instead, they evaluate and adapt the outputs from AI-powered conversational agents to develop contextualized lesson plans, while acknowledging and addressing inaccuracies in the information provided (van den Berg & du Plessis, 2023). However, there has been limited research on the moment-to-moment process of how teacher candidates *actually* construct a prompt and evaluate outputs from AI-powered conversation agents to develop lesson plans. Knowledge construction is not static, rather it is "topic dependent and negotiated in the interaction" (Llompart, 2021, p. 64). For example, when teacher candidates have substantially less knowledge than ChatGPT on a particular topic, they might accept ChatGPT's output without critique. We argue that the curation process of selecting and building knowledge for a lesson plan is negotiated when using AI-powered conversation agents. This process warrants further study to inform educational activities and guidelines that support formative and critical reflection of teachers and teacher candidates regarding AI–human collaboration, particularly about lesson planning.

In this study, we focus on moment-to-moment dynamics of conversation between four pairs of teacher candidates and ChatGPT (GPT-3.5) during a mathematics lesson planning activity. We adopted Heritage's (2012a) gradient model of epistemic stance as a lens to capture how teachers positioned knowledge they hold and acquired from ChatGPT, as managed through their prompts and question inputs. Looking closely at the turn construction enables us to see how interactions move action forward between ChatGPT and teacher candidates. Also, attending to the notion of epistemic stance––discussed in detail in Section "Conceptual Framework"—can reveal how teacher candidates interact with resources from ChatGPT in ways that reveal what they feel experts in and what they entrust to knowledgeable others.

Research has demonstrated that ChatGPT outputs, generated by a prompt, can be considered as human-like data in a conversation analysis (CA) (Chen et al., 2024) without anthropomorphizing their conversational capacity. Thus, our primary data involve teacher candidates' text prompt input to ChatGPT (texts that query or request something from AI) and their responses to the ChatGPT outputs captured by teacher candidates' utterances and follow-up prompts. This study does not intend to provide a definitive argument on the use of ChatGPT. Instead, it aims to generate insights for teacher educators on how teacher candidates purposefully use questions and answers to accomplish their intended actions (e.g., lesson planning) when using ChatGPT. The following research question guided our inquiry: How might Heritage's gradient model of epistemic stance be mobilized to reveal the ways that teacher candidates position themselves in working with ChatGPT?

Conceptual Framework

AI as an Epistemic Agent: From Interaction Through *AI to Interaction* With *AI*

This study is grounded in Bisconti et al.'s (2024) conceptualization that generative AI is a social agent, which generates knowledge *with* humans in an unprecedented way. They highlight, "AI systems are capable of creating new semantic artifacts that contribute to our collective knowledge and circulate in social systems" (Bisconti et al., 2024, p. 94). Given their capacity for poiesis, or autonomy in semantic production, AI agents have become coproducers of knowledge with the ability to alter configurations of social relations.

Rooted in a notion of the reciprocal relationship between technology and society as a sociotechnical system (Ropohl, 1999), Bisconti et al. claim that the arrival of advanced generative AI systems and large language models "make[s] a shift from technologies that we interact *through* to technologies we interact *with*" (p. 93). In stark contrast to prior tools (e.g., phone, Facebook, and social media), artificial agents such as ChatGPT engage in a wide range of social interactions with human beings. As an example, ChatGPT can process information, "build narratives, alter relationships between facts and their interpretations directly, shape social values by discussing them, and contribute to the broader ecosystem of interactions that constitute our social systems" (p. 94). Because of these interaction capabilities, Bisconti et al. argue that generative AI can alter the "overall configuration of relations and contribute to [the] collaborative production of knowledge" (p. 94).

Our study agrees with Bisconti et al.'s (2024) view that knowledge generation is relational and distributed among social agents in a sociotechnical system. We position ChatGPT as a social agent, representing a form of technological integration within our social environment that moves beyond mediation toward interaction. In addition, we extend Bisconti et al.'s (2024) conceptual case into a teacher education setting and aim to detail the configuration of relations in which these agents engage in collaborative lesson planning. We also are focusing on the qualities of how teacher candidates position themselves in relationship to ChatGPT in ways that are dynamic and emergent rather than fixed or inherent.

Prior studies in the education literature have primarily focused on studying the technical capabilities of ChatGPT (Hatmanto & Sari, 2023). In contrast, our study zooms in on the meanings that emerge for the teacher candidates through the dynamic interactions with AI's outputs (see Figure 1). In this case, we, authors, collectively conceptualize AI as a social agent embedded in a sociotechnical system, enabling the analysis of dynamics that emerge in conversations between ChatGPT and teacher candidates. However, we also acknowledge that, as individual researchers, we are open to exploring and adopting different orientations toward

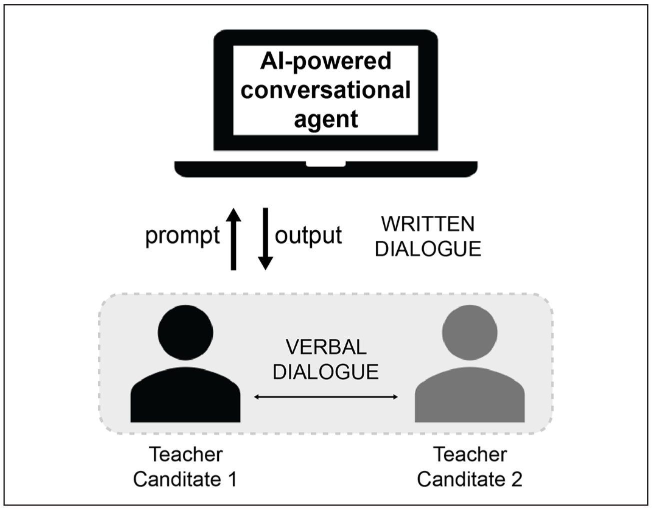


Figure 1. Visual Model of the Written Dialogue Between an AI-Powered Conversational Agent and Teacher Candidates, and the Verbal Dialogue Between the Teacher Candidates.
Note. Two teacher candidates worked in pairs with ChatGPT in developing a lesson, and one of them primarily inputs the prompt into ChatGPT. We illustrate this information by representing the primary input teacher candidate in black, and the other one in gray.

AI in response to its rapid advancements, the emergence of new ethical problems, and the need for proactive engaging with it.

Heritage's Gradient Model of Epistemic Stance

We draw on Heritage's (2012a, 2012b) gradient model of epistemic stance to understand the dynamics of interactions between a teacher candidate pair and ChatGPT. Heritage presents three key terms that describe how the content and positioning of questions in conversations reveal and shape social actions: *territories of knowledge, epistemic status, and epistemic stance*.

Territories of knowledge refer to the generally accepted and understood domains of knowledge that an individual might occupy (Heritage, 2012b). It deals with "what is known, how it is known, and persons' rights and responsibilities to know it" (Heritage, 2012a, p. 6). This means there are certain territories of knowledge that one is considered and expected to know more about such as one's thoughts, experiences, job, and relatives.

Epistemic status is "for the most part a presupposed or agreed upon, and therefore real and enduring, state of affairs" (Heritage, 2012a, p. 6). Thus, one is considered to have a higher epistemic status in contexts where it is deemed by conversational partners that the desired information falls within the other's territory of knowledge. How a speaker poses questions can be closely examined to detect a speakers' perception of the recipient's epistemic status. Some examples are display questions (requesting known information for which the speaker may have shared knowledge territory) or referential questions (requesting unknown information which the speaker places within the receiver's territory of knowledge). In the context of using ChatGPT, for example, when teachers input queries on a search engine, they may ask a question that they already know to check whether ChatGPT offers valid information (display questions). At other times, they can ask questions to ChatGPT to obtain information that they are not familiar with (referential questions).

Recent literature has begun to discuss the epistemic status of AI. Alvarado (2023) argues that AI is an epistemic technology, unlike other technologies, due to its ability to inquire about context, manipulate data, conduct an analysis, and make predictions like humans (Alvarado, 2023). However, the epistemic status of AI can be more complex and nuanced compared with that of humans. A person's epistemic status—such as in teacher–student or doctor–patient relationships—is often asymmetrical and relatively stable. Teachers and doctors are considered as authoritative figures and primary knowledge holders in their respective fields. Conversely, the socially agreed-upon epistemic status of AI remains relatively fluid and highly context-dependent. AI systems are "repositories of extensive, weak knowledge (Ferrario et al., 2024, p. 30)" that do not hold the ability to understand the meaning behind data. Therefore, while sometimes AI can provide accurate information, which could elevate its epistemic status, they also offer incorrect information and do not possess critical thinking skills and context-specific knowledge.

Heritage (2012a) distinguishes epistemic status and epistemic stance. Although epistemic status is an underlying state of knowledge that one holds, *epistemic stance* is one's momentary positioning, which is encoded in "the moment-by-moment expression of these (social) relationships" (Heritage, 2012a, p. 6). Building on the idea of epistemic status as relative and context-dependent based on a speaker's and recipient's access to territories of knowledge (Heritage, 2012b), Heritage argued that conversational partners take an *epistemic stance* toward each other in conversation, a stance which is encoded within the grammar of their utterances. He uses the following utterances to explain his notion, the gradient model of epistemic stance, which indicates the higher or lower epistemic stance between a speaker and a recipient: (a) Are you married? (b) You are married, aren't you? And (c) You're married. Utterance (a) expresses that the questioner has no absolute knowledge of the recipient's marital status. However, utterances (b) and (c) indicate "increasing commitment to the likelihood that the recipient is married" (Heritage, 2012a, p. 6). These relationships are represented in Figure 2. K+ refers to more knowledgeable, and K− indicates less knowledgeable. In Utterance (a), the speaker's epistemic stance (K−) is lower than the recipient's epistemic stance (K+), represented by the steepest slope line. Utterances (b) and (c) are more gently sloped.

Individuals may differently assess the status of AI and position their relationship to the AI's knowledge (e.g., Alvarado, 2023; Ferrario et al., 2024). Recognizing the

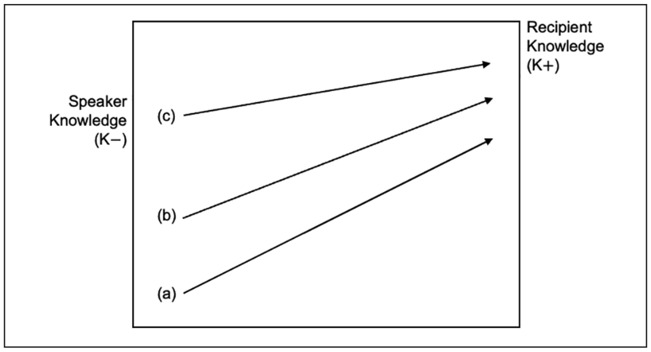


Figure 2. Epistemic Stance (a)–(c) Represented as an Epistemic Gradient (K+ and K−) for Three Questions: (a) Are You Married? (b) You Are Married, Aren't You? and (c) You Are Married (Adopted From Heritage, 2012a, p. 7).
Note. The arrows do not represent the progression of epistemic stance over time. Instead, they illustrate how participants adopted either a higher or lower epistemic stance in the conversation.

abilities and limitations of ChatGPT not just a priori but also in real-time interactions is essential for effectively integrating it into education. In this study, we take up Heritage's (2012a, 2012b) study to map when, why, and with what information educators take a higher epistemic stance (K+), versus a lower epistemic stance (K−) than ChatGPT.

Literature Review

Lesson Planning and AI-Powered Conversation Agents

Developing a lesson plan is an important task for achieving high-quality mathematics education (Lloyd et al., 2017). As a teacher's intended curriculum, a lesson plan influences their instructional practices and student outcomes. Teachers need to decide what to teach and how to teach, when developing a lesson plan (Kang, 2017). In addition, they should consider the objectives of the designated curriculum and their students' mathematical (mis)understanding and local contexts (Lloyd et al., 2017). Thus, "the process of planning is creative and essentially bounded by contextualized knowledge, including detailed understanding of teachers' students" (Kang, 2017, p. 56).

Teacher candidates often have difficulty in developing lesson plans as their relevant knowledge is still developing (Mutton et al., 2011). They may not be exposed to sufficient opportunities to explore the knowledge of students' mathematical thinking and needs (Kang, 2017). For example, when teacher candidates are creating a lesson plan for teaching fractions that applies Universal Design for Learning (UDL),[1] it should differ from other lesson plans (Lambert, 2021). This is because elementary students often struggle with fractions due to the "whole number bias," in which numerators and denominators are treated as distinct whole numbers (Krowka & Fuchs, 2017, p. 216), particularly severe for students with mathematics difficulties, which made UDL-based strategies needed for lesson planning.

Notable design elements of UDL-focused lessons are engagement, representation, and strategic action to enhance student's understanding and participation in learning content (see Table 1). In addition, teachers must understand the distinctions between fractions using continuous and discrete models (Rapp et al., 2015). The discrete model can be effective when teaching adding fractions with unlike denominators, as it helps students easily find common denominators. However, the continuous model is more suitable for teaching concepts, such as length and volume, where quantities are measured rather than counted (see Table 2). However, some educators may not have strong mathematics content knowledge and it can result in less mathematically rigorous lesson plans (Lloyd et al., 2017).

Teacher candidates require support to help them develop proficiency in their lesson plans (Lilly et al., 2024). However, teacher education programs focus on teaching instructional skills in classrooms, and course instructors often lack sufficient time to provide feedback on the lesson plans developed by them (Kang, 2017). Consequently, teacher candidates tend to seek various resources (e.g., ChatGPT) to acquire relevant knowledge and skills, and save time and effort in lesson planning (Lilly et al., 2024; Sawyer et al., 2020). Its ability to generate plausible, personalized responses, coupled with its self-improving capabilities, makes it a valuable resource (Corp & Revelle, 2023; Farrokhnia et al., 2024).

However, researchers have expressed concern about the overreliance on ChatGPT due to its occasional inaccuracies and fabricated information (Farrokhnia et al., 2024). When ChatGPT is unable to provide information for a user's personalized request, it may generate fabricated responses that appear plausible (Davis & Lee, 2023). It is also unclear whether using ChatGPT's capabilities to quickly provide information will lead to meaningful learning opportunities for preservice teachers, allowing them to build on the experience. In addition, it is unclear how these opportunities can be created in teacher education courses. Therefore, when designing lesson plans, teacher educators should not only rely on the information provided by ChatGPT but also evaluate its accuracy and make necessary selections for their students.

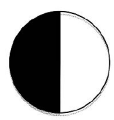
Mathematical Knowledge for Teaching

Ball and her colleagues (Ball et al., 2008) found that mathematics teachers require distinct types of knowledge for teaching mathematics, as revealed through the teaching practices of mathematics educators. They termed this specialized knowledge "Mathematical Knowledge for Teaching" (Ball et al., 2008, p. 389). They identified two primary mathematical knowledge for teaching: subject matter knowledge and pedagogical content knowledge. First, subject matter knowledge refers to knowledge about mathematical concepts, principles,

Table 1. UDL Mathematics Design Elements (Adapted From the Work by Lambert, 2021).

UDL principle	Mathematics design element	Guiding questions
Engagement: Stimulate motivation for learning	Meaningful mathematics	Is mathematics in your class meaningful to students?
	Supportive classroom environment	Do your students feel safe enough to take mathematical risks?
Representation: Present content in various ways	Multimodal	Is mathematics content accessible? Multimodal?
	Focus on core ideas	Does the design of your class guide students to understand core mathematical ideas?
Strategic action: Differentiate the ways that students can express their knowledge	Understanding self as a mathematics learner	What do students learn about themselves as mathematics learners?
	Equitable feedback	Is assessment equitable for all learners?

Table 2. The Difference Between Fraction With Discrete and Continuous Model (Adopted From the Work by Rapp et al., 2015).

Model	Definition and example	Representation
Discrete	A model representing the counting of discrete objects in fractions, such as "1/2 of the balls are black."	●●●●○○○○
Continuous	A model representing continuous quantities in fractions, such as "1/2 of a pizza," involves dividing a whole.	

and processes. Ball et al. (2008) listed three subdomains specific to subject matter knowledge: common content knowledge (mathematical knowledge used in any setting, including teaching), specialized content knowledge (mathematical knowledge uniquely needed for teaching), and horizon content knowledge (mathematical knowledge about how mathematical topics are relevant to other topics in the curriculum).

The second primary domain is pedagogical content knowledge (Ball et al., 2008). This knowledge domain also includes the three subdomains: knowledge of content and students (knowledge about student mathematical understanding and errors), knowledge of content and teaching (knowledge about instructional design and mathematical tasks), and knowledge of content and curriculum (knowledge about the depth and breadth of mathematics curriculum). As mathematics knowledge for teaching presented by ChatGPT influences the responses of teacher candidates, we take up Ball et al.'s (2008) framework to understand what domains of mathematics knowledge for teaching teacher candidates take a higher or lower epistemic stance during the conversation with ChatGPT.

Conversational Analysis

CA examines how action is carried out between people in conversation, with co-participants listening, monitoring, and evaluating preceding turns to construct their subsequent responses (Jefferson, 1984; Schegloff, 2007). In generating a meaningful conversation, participants actively process the conversation for assess key aspects, such as when it is appropriate to speak, what should follow next, and why a speaker uses specific words at a given moment. This method emphasizes recognizing patterns in how people communicate and how their speech is interpreted within the conversation.

CA has also been taken up as a method for understanding the engagement between humans and voice or text technologies that appear as responsive conversation participants. This scholarship (e.g., Luff et al., 1990), prominent in the 1990s with emerging chat engines, came with scrutiny to the challenges and possibilities of framing such interactions. Stokoe et al. (2024) highlight the importance of focusing on the technology of conversation and attending to the "progressivity of interaction, rather than the security of intersubjective understanding" (p. 6). These studies collectively suggest that interactions between teacher candidates and ChatGPT can be examined through the lens of CA while not ascribing an anthropomorphic humanness to the AI generators by grounding understandings in the accomplishment of actions by participants.

Method

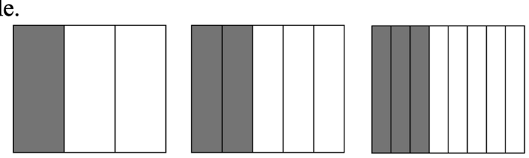
Recruitment, Research Site, and Participants

This study is an intrinsic case study (Stake, 2005) focusing on a specific segment of a larger research project that explores how teacher candidates integrate technology into mathematics teaching. This approach was chosen to investigate the unique complexities of the conversational dynamics that emerge between ChatGPT and teacher candidates. Table 3 shows research participants' demographic information. The participants attended a core education course in a master's level teacher education program in the northeastern United States in the school year of 2023–2024. Although all of them worked at a school at the time of data collection, they did not yet obtain state-issued teacher licensure. For demographic information, we collected their familiarity with UDL,

Table 3. Demographic Information of Participants.

	Familiarity with				
Name (Pseudonym)	UDL	Mathematics lesson planning and teaching	ChatGPT	Gender	Race
Hally	Familiar	Very familiar	Familiar	Female	White
Ramy	Slightly familiar	Not familiar	Not familiar	Female	White
Jake	Not familiar	Slightly familiar	Familiar	Male	White
Nara	Not familiar	Very familiar	Very familiar	Female	White
Sam	Slightly familiar	Slightly familiar	Very familiar	Male	White
Riley	Familiar	Very familiar	Very familiar	Male	White
Timothy	Familiar	Slightly familiar	Slightly familiar	Male	White
Dave	Slightly familiar	Not familiar	Slightly familiar	Male	Black

Context: Below is how Lisa solves a fraction addition problem. When interpreting or manipulating fractional representations, Lisa often overapplied a discrete set model to continuous models in which she ignored the size of the parts and treated all parts as if they were interchangeable.



$$\frac{1}{3} \quad + \quad \frac{2}{5} \quad = \quad \frac{3}{8}$$

Create a mathematics lesson plan to support her approach to fraction addition. Lisa is a 19-year old community college student who is assigned to a remedial mathematics class, native English speaker, not low SES, and has no attention or behavior issues.

Figure 3. Lesson Plan Development Guideline (Adapted From the Work by Lewis, 2014).
*Note.*The provided guideline did not include the full name of SES, which stands for socioeconomic status.

mathematics lesson planning and teaching, and ChatGPT because we assumed if a participant perceives familiarity with one of these three indicators, they are likely to consider it to be within their territory of knowledge. This assumption aligned how the participants noted their epistemic status in our data, (e.g., Nara indicated that she is "very familiar" with mathematics lesson planning in the pre-activity questionnaire, and then during the lesson planning activity, she claims her expertise in teaching mathematics).

Data Collection

Before the lesson planning activity, participants had read Lambert's (2021) article that proposed a way to apply UDL to planning mathematics lessons (see Table 1). The instructor presented lesson plan development guidelines (Figure 3). The instructor explained to the participants that the lesson plan would focus on Lisa, a 19-year-old college student who appeared in Lewis's (2014) article. Lisa's profile served as a case study for teacher candidates to address differentiating a lesson for a student who demonstrated confusion with adding fractions in a remedial college mathematics course. Such a learning challenge was defined as coming from overapplying a discrete set model (fractions as part of a whole) to a continuous model (fractions as length or area). Therefore, a lesson plan needs to support Lisa in expanding her fraction understanding to a continuous model. The instructor asked the participants to consider how to apply UDL principles to address Lisa's learning challenge.

The eight participants were randomly assigned to a pair and were placed in different classrooms to conduct a lesson planning activity. A lesson plan template was provided to the pairs (see Appendix A). Although the relevant mathematics content standards were included in the template, the pairs were asked to create lesson objectives, assessment plans, lesson materials, and lesson procedures using ChatGPT. Next, each pair started recording their computer screen and their voices using Zoom's built-in recording feature.

After completing the lesson planning activity, each pair submitted their self-recorded videos, mathematics lesson plans, and conversation with ChatGPT. The authors transcribed the audio-recorded dialogue between the pairs. The statistics of the audio-recorded dialogues are provided in Table 4. Finally, after the lesson planning activity, teacher

Table 4. Statistics of Audio-recorded Dialogues Between Participating Pairs From the Video Clips.

Audio-recorded Dialogues	Pair 1. Sam and Timothy	Pair 2. Nara and Ramy	Pair 3. Riley and Dave	Pair 4. Jake and Hally
Number of words	3,632	1,682	5,547	1,305
Number of characters excluding spaces	16,232	7,338	25,365	6,951
Length of a video clip (min)	42	16	47	19

candidates debriefed their activity for about 1 hr, including electronically writing a post-activity reflection journal. This information helped the authors to better understand why they used certain questions to ChatGPT to create a mathematics lesson plan and how the prompts differed (see Appendix B).

Data Analysis

The intrinsic case study approach helps researchers understand the unique characteristics and context of a specific case in research design. Alongside this design, we take up Bisconti et al.'s (2024) emphasis that "existing analytical frameworks for analysing human-machine relationships appear inappropriate for considering synthetic socio-technical systems" (p.6). Hence, for our analytic method, we lean on ethnomethodology's commitment to the work happening between conversation partners, which enables researchers to understand how individuals organize their interactions and make their communication purposeful and meaningful for the achievement of specific interactional goals (Yin, 2015). Thus, this study combines an intrinsic case study approach with an ethnomethodological, analytic lens to uncover the detailed interactional practices that reveal teacher candidates' decision-making processes, and their epistemic stance and status, when using ChatGPT.

To reveal critical elements of teacher–ChatGPT interactions, we adopted video analysis, a process of looking at written and verbal data to ground understandings in observations and inductive evidence from the talk and activities of the participants in relation to specific contexts and present purposes (Koschmann et al., 2007). We began by watching and rewatching self-recorded screen capture videos of teacher candidates with transcriptions, taking analytic memos on key interactions and emerging patterns. During this process, individual authors analyzed the collected data with a deductive focus on territories of knowledge, epistemic status, and epistemic stance. In the first round of analysis, we divided the transcriptions into excerpts that revealed the epistemic stance of teacher candidates toward ChatGPT using types of questions (e.g., display or referential questions) and responses (e.g., accept, appraise, and criticize). Building on Heritage's (2012a) distinction between higher (K+) and lower (K−) epistemic stances, we developed a priori codes to examine whether teacher candidates adopt a higher, lower, or equal epistemic stance in relation to ChatGPT. In addition, we recognize that a teacher candidate's epistemic stance toward AI can shift during a conversation (Alvarado, 2023).

We categorized the conversations into three types based on the teacher candidates' epistemic stance (higher [K+], lower [K−], or equal), and closely examined why these stances were taken and how the territory of knowledge (e.g., mathematics knowledge for teaching and familiarity with UDL) played a role. Afterward, we met to re-examine the data and share meaningful observations, including key moments of talk, and map patterns of interaction that might inform our research questions. In our findings, we provide transcribed excerpts using Jeffersonian transcription to further describe key interactional moments between teacher candidates and ChatGPT (Hepburn & Bolden, 2018).

Findings

Our findings demonstrate how Heritage's epistemic stance can be mobilized to reveal the ways that teacher candidates position themselves in lesson planning with ChatGPT. As teacher candidates formulated their prompts for input into ChatGPT, they also discussed their reasoning behind the prompts. Through this interaction around ChatGPT prompts and responses, we began to understand what and why questions are posed with K+/K− epistemic stance. We draw attention to how educators negotiated their epistemic territory, positioning knowledge they hold relative to their perceptions of what ChatGPT knows. Attending to the positioning of who has higher epistemic status and when in relation to ChatGPT, we organized findings into the following three sections: (a) teacher candidates (K+) took a higher epistemic stance than ChatGPT (K−), (b) teacher candidates (K−) took a lower epistemic stance than ChatGPT (K+), (c) co-equal epistemic stance between teacher candidates and ChatGPT. Each section presents exemplary excerpts from our data and analysis following the traditions of a CA paper (Jefferson, 1984).

Teacher Candidates Took a Higher Epistemic Stance Than ChatGPT

At times, teacher candidates queried ChatGPT with information-confirming and information-seeking display questions. When teacher candidates evaluated outputs from ChatGPT, they demonstrated their positioning as holding a higher epistemic stance than ChatGPT. Below, we show the nuance seen in the K+ (educator) → K− (ChatGPT) stance taken by teacher candidates:

Excerpt #1. Establishing the trustworthiness of ChatGPT

1 **Sam:** ((typing into text box and voicing out loud))
2 ↑ Hey (.) do (.) you (.) understand the teachi::ng (.)
3 concepts >of UDL<↓
4 (15) [ChatGPT responds with explanation of UDL
5 principles]
6 **Sam:** Wonderful ↓ (h) (.)
[types into chatGPT prompt box] Wonderful.

In Excerpt #1, Sam posed a question to ChatGPT in Line 2, asking ChatGPT "do you understand. . ." the concepts of UDL. With this question, Sam *requested information* using a display question. Given the course has covered UDL, Sam had a grasp of the content and was curious if knowledge of UDL was potentially within the epistemic territory of ChatGPT: he was testing the bounds of ChatGPT's knowledge. When ChatGPT returned information in Line 4, a response that was in alignment with Sam's own understanding of UDL, he responded in Line 6 with "Wonderful." With this response, Sam was *evaluating and confirming*, with the initial prompts as a display type question. The turn-by-turn here suggested that both Sam and ChatGPT have knowledge of UDL, falling within both of their epistemic territory. However, Sam's response of a confirmation of ChatGPT's knowledge of UDL placed Sam at a slightly higher epistemic stance, with the power to confirm or deny ChatGPT's response. Visualized as a gradient, the K+/− slope rises from ChatGPT toward Sam.

As teacher candidates negotiated the relationship between what they know and what ChatGPT knows, it became clear that some teacher candidates identified their epistemic status as relevant to the action they would undertake. Teacher candidate Nara (Excerpt #2) named that she had taught mathematics for many years, describing herself as a person who "knows the objectives," and proceeded to name each necessary objective in Lines 6–17, a point which is related to her understanding of mathematics knowledge for teaching:

Excerpt #2. Claiming expertise (1)

1 **Nara:** We'll do (.) we'll fill out the first and then we'll use
2 chat[GPT]
3 **Ramy:** [yea]
4 **Nara:** at the [end(.)]
5 **Ramy:** [yea]
6 **Nara:** to do the lesson plan. So:: since I teach fractions a lot I
7 kno::w the objectives↑.
8 So (.) our first objective (.) would be (.) um (.) the
9 concept of fractions (.) um a::nd (.) um numerator
10 versus denominator [2]
11 **Ramy:** =um:: denominator
12 ((typing into chatGPT))
13 **Nara:** Our second objectiv::e (.) >would be adding with like
14 denominators↓<
15 Then the last objective would be adding with
16 unlike↑denominators (.)
17 >I like to keep addition and subtraction separate<

In this side talk with her partner (Ramy), Nara outlined the sequence of interactions she would use with ChatGPT, as teaching fractions fell within her area of expertise. Given her own epistemic status regarding mathematics knowledge for teaching, her use positioned ChatGPT as having a lower epistemic status, queried only after she had written her own version of the fractions lesson plan:

Excerpt #3. Claiming expertise (2)

1 **Nara:** [talk directed at Ramy]
2 S:o >what you're going to type in<
3 **Instructor:** =mm::mm
4 **Nara:** explain what a fraction is (.) [starting with]
5 **Instructor:** [um::] the meaning of
6 the fraction (.) Oka:y
7 **Nara:** =explain what a fraction is (.) um (.) and (.) um
8 ↓°what did I say°↑( ) (3)
9 >explain what fractions are< and what they
10 represent at a second grade level.
11 **Ramy:** =oh ri:ght
12 **Instructor:** =mm::[mm]
13 **Nara:** [period] >Give real life examples< of fractions↓

Nara then asked Ramy to prompt ChatGPT with a request to come up with an idea of how to explain fractions to second graders, based on Nara's assessment of Lisa's level of understanding of fractions (Lines 1–6). For Nara, this request to ChatGPT was a display question as she already claimed to know how to teach fractions in Excerpt #2. Following Excerpt #3, Nara immediately takes up the information from ChatGPT and copies it over to her planning document rather than asking follow-up questions to ChatGPT, or picking and choosing parts to add. Both Excerpts #2 and #3 show that teacher candidates claimed a higher epistemic stance than ChatGPT by intentionally not asking a question to ChatGPT when developing a lesson objective (Excerpt #2), or asking a display question for which the teacher candidate already knows the answer

(Excerpt #3). The kinds of knowledge that the educators in Excerpts #1 through #3 confirmed were mathematics knowledge for teaching, including specialized content knowledge (e.g., the meaning of fraction) and pedagogical content knowledge (e.g., how to teach fraction).

Teacher Candidates Took a Lower Epistemic Stance Than ChatGPT

Teacher candidates also queried ChatGPT with information-seeking referential questions, positioning themselves in a lower epistemic stance than ChatGPT. In the following examples (Excerpts #4–7), we demonstrate the nuance seen in the K− (educator) → K+ (ChatGPT) stance taken by teacher candidates:

Excerpt #4. Requesting information

1 **Sam:** >Because I thought this was< a challenging subject
2 (.) >I'm going to move over
3 to my screen and announce that (.) u::h (.) I have
4 already put the L3(.)
5 ((In the course slides L3 indicates when interpreting
6 or manipulating fractional representations, Lisa often
7 overapplied a discrete set model to continuous models
8 in which she ignored the size of the parts and treated
9 all parts as if they were interchangeable))
10 uh (.) issue (..) stumbling block that Lisa is having and
11 explaining it to me in better terms (_) (.) as I am not a
12 (..) math ↑teacher (.).hhh Uh (.) so:: (.) yeah (¿) and
13 then (.) uh (.) already I've moved further on to sa:y (.)
14 WHat strategies could I use >to help a student< like
15 (.) this learn how to add fractions↑(.) I have not read
16 into this too deeply yet (.) but (..) uh .hhh (.)
17 °that's what° that's (..) >You're all caught up ↓now
18 recording(¿)
19 That's (.) that's what I ↑did when I wasn't recording↓
20 (.) So £ya:y£ (.) here we are (hh).hhh (.) So I guess (.)
21 u::h
22 Oka:y (4) Looking over this ver:y daunting sheet (hh)
23 ((Sam looks through a Lesson Template))
24 U::h (1)((reading screen)) >Use equivalent fractions
25 to add< .hhh
26 (10) Content (.) Objectives↓ Objectives should be:
27 inclusive and accessible and ↓cross-cutting (.).hhh
28 Objectives should also be singular (.) measurable (.)
29 and aligned to (.) lesson procedure and assessment
30 .hhh
31 (7) So I::m going to go back over to >here we go<
32 UDL:
33 ((reading UDL Tool and scrolling through UDL Math
34 Design Elements course slide))
35 All right (.) ↑well (.) let's see (.) I'm incorporating the
36 strategies.

In Excerpt #4, Sam took a lower epistemic stance than ChatGPT regarding mathematics terms (specialized content knowledge). He noted from the outset that he began the activity by asking ChatGPT about Lisa's learning challenge, having it, "explain to me in better terms, as I am not a math teacher" (Lines 11–12). In retelling this encounter, Sam stated, "And that's how we started getting all these other examples that we got to choose the best one from." We note Sam's initial efforts to assess, establish, and articulate his own territory of knowledge as a way to determine a content focus for the questions he and his peer might ask ChatGPT. In talking through his thinking, Sam took a lower epistemic stance in relation to ChatGPT regarding an understanding of the term "discrete set model" and its application to Lisa's case. His referential question implied that he positions ChatGPT as having a higher epistemic status over this knowledge territory as he is "not a math teacher." Naming that he got to "choose the best one" then revealed his higher epistemic stance over which option will be the best for the particular lesson.

The end of Excerpt #5 further shows Sam taking a more leveled, but still lower epistemic stance than ChatGPT. This epistemic gradient differed from his initial footing that took a more sloped and lower epistemic stance by saying "I am not [a] mathematics teacher."

Excerpt #5. Surprise and learning

1 **Sam:** °Knowing this° ((Sam proceeds to type into prompt
2 box))
3 (42)
4 **Sam:** >Oh my< (hh) (.) They gave- (.) So:- I::
5 >I typed in< (.) u:::h (.) okay (.) Knowing this: (.)
6 what are some sample objectives ↑using UDL↓that
7 could apply to a lesson about adding fractions↓?=
8 **Timothy:** =Ye[ah]
9 **Sam:** ((Sam scrolls through ChatGPTs response))
10 [A::]nd (.) u:::h (.) ChatGPT gave me nine↓ (..)
11 (hh)
12 So we ha:ve under representation ((reading off
13 screen))
14 ↓>Students will be able to represent fractions
15 using< ↑visual models (.) including bars (.) circles
16 or number lines (.) and describe >the addition
17 process< using both ve:rbal and vi:sual
18 explanations (.) .hhh ↑I like that (.) that makes
19 sense to [me] (..)
20 **Timothy:** [Sure]
21 **Sam:** So:: (.) u::h >and I understand< what that
22 means

Sam's question in Line 1 asked ChatGPT to apply its knowledge of UDL to a lesson plan on adding fractions (Line 7).

After reading through ChatGPT's response, on Line 4 Sam said, "Oh my!" suggesting, through this change-of-state token (Heritage, 1984), that the information offered by ChatGPT was greater than he initially thought in the AI's epistemic territory of knowledge. Sam's language confirming that ChatGPT "makes sense" (Lines 18-19) and that he "understands" (Line 21), was not evaluative, rather it was affirming, demonstrating a slightly lower epistemic stance to ChatGPT. In this completion of action, Sam demonstrated that in the context of setting lesson objectives, he must first establish the epistemic status of ChatGPT regarding the topic (see Excerpt #1) before ensuring that ChatGPT can be trusted as a more knowledgeable other. This positioning came up again later on, seen in Excerpt #6:

Excerpt #6. Querying for options

1	**Sam:**	Ye::h
2		((Reading assigned lesson plan template,
3		specifically Evidence and Assessment section))
4		How will ↓we measure pro:: .hh student progress
5		towards(¿) objectives (.) What evidence will
6		sho:::whh- (..)
7		>Do you know what↑< I'm cur-curious (.) £Out
8		of curiosity£ They're ((meaning the lesson
9		template)) asking us this question↓
10		((Sam copies and pastes the lesson template
11		content and insert it into ChatGPT))
12	**Timothy:**	Is that (.) like (.) rhetorical↑though (.) or is that
13		(.) [like just for us
14	**Sam:**	[Well:::]
15	**Timothy:**	-to consider in that]
16	**Sam:**	=Let's see what the ↑robot ((meaning ChatGPT))
17		says↓ (hh)
18		(7) ((Reading the ChatGPT's response))
19		>ºHow do you measure the progress towards
20		objectivesº<
21		Measuring student progress >towards the
22		objectives in a way that reflects< equitable
23		assessment is CRUcial >to UDL informed
24		lessons (.) Here are some< <assessment
25		strategies>
26		(9) Multiple mean- (.) I like that (.) multiple
27		means of represe:ntative assessment (..) cause::
28		(1) we mi:ght (.) >you know< if she's (.hhh)
29		having difficulty:: with th- the: example they
30		showed with just the colored in bars (..) that just
31		might not be the <visual representation> that
32		CLICKS [with her]
33	**Timothy:**	[yeah]

In this excerpt (Excerpt #6), Sam again tested what ChatGPT will offer, saying, "Let's see what the robot says" (Lines 16—17). Sam's question was a direct request for information, which displayed Sam's lower epistemic stance in relation to ChatGPT. The ensuing demonstration of epistemic territory is interesting because Sam then affiliated with ChatGPT given the information offered, seen in the line "I like that multiple means of representative assessment" (Lines 26-27). This utterance implied (a) that Sam acknowledged that information on mathematics learning assessment falls within ChatGPT's territory of knowledge and (b) showed he is taking a higher epistemic stance at this moment in relation to ChatGPT by confirming the appropriateness of the information. Yet, he also received new information regarding the objectives for the lesson, particularly here "multiple means" indicating that ChatGPT may have a higher epistemic status over this domain knowledge than Sam.

As we noted in Excerpt #5 *Surprise and learning*, there are also moments where teacher candidates express surprise through change-of-state tokens that position themselves as K− to ChatGPT. In Excerpt #7, Nara was, again, surprised by the response ChatGPT offered to her input:

Excerpt #7. Taking the advice of ChatGPT

1	**Nara:**	Our ↑next one (..) is going ↓to be (.) u::m (..)
2		explai::n(¿) how to add (.) proper
3		fractions (.) u::m (..) using cross multiplication↓
4	**Ramy:**	mmkkk ((typing what Nara says into ChatGPT))
5		(1) >at a second-grade level<
6		((ChatGPT generates outputs))
7	**Ramy:**	.hhh ((Reading ChatGPT's outputs aloud)) (hh)
8		£typically at a more advanced
9		level£ >not second grade< (hh)
10		(8)
11	**Nara:**	O:::h↓ .hhh (.) CROSS-multiplication is doing it for
12		proportion (.) So that's
13		not the way I'm supposed to (..) U:m: (..)
14		Crohhhss multiplication isn't the right term↓ (.) U::m::
15	**Ramy:**	=should I £thank ChatGPT£ [(hh)]
16	**Nara:**	[Thank it↓] we should be
17		happy
18		U:::m (.) so instead of cross multiplication (..) we're
19		going to d::o (.) U::m (.)
20		>so copy< the same thing
21	**Ramy:**	=Okay
22	**Nara:**	=But then get rid of cross multiplication↑
23		(12) ((Nara says out loud what she wants Ramy to add/
24		type into ChatGPT. We see Ramy copying and pasting
25		into the prompt box in the screen recording))
26		U::m (.) u:sing (.) >or take out using too< and then
27		put in by (..) BY:: (.) u:m (.) Cross-multiplying the
28		denominators↓ >ºMake it more specificº<
29		(4) to get a common denominator↓
30	**Ramy:**	(9) Good↑

Nara: =>Yep< (9)
The::re we go (.) >Now it's gonna< give it to us
right↓
Ramy: (4) All ri::ght(¿)
Nara: (3) I think it's funny that it realizes that you don't do
that in second grade↓

In Lines 1–3, Nara asked Ramy to draft a particular question prompt (i.e., how to add proper fractions) for ChatGPT using the declarative syntax (i.e., Our next one is going to be). These lines also showed that Nara believed typical second graders can solve problems involving the addition of proper fractions, even though the Common Core State Standards (CCSS) usually teaches this topic to fourth graders. When ChatGPT responded (Line 6), Ramy read out with laughter in Lines 8 and 9, "typically at a more advanced level, not second grade." Nara responded in Line 11 with a change of state token "oh," recognizing a problem with her initial prompt and taking a lower epistemic stance to ChatGPT regarding cross-multiplication. Thinking through the problem regarding such mathematical knowledge uniquely needed for teaching aloud, she then identified and added to her prompt to clarify and remove the incorrect information (Line 18). In Excerpt #7, Nara paused and reevaluated her phrasing and problem construction, returning to reprompt ChatGPT with different language, unlike Excerpt #2 where she simply copied and pasted the output from ChatGPT claiming her status as "I know the objectives."

Co-Equal Epistemic Stance Between Teacher Candidates and ChatGPT

The educators and ChatGPT are not always in an imbalanced epistemic hierarchy. A more equal epistemic stance can happen by negotiating across different territories of knowledge (Heritage, 2012a). This section highlights two excerpts that illustrate how teacher candidates take a more equal epistemic stance:

Excerpt #8. Unknown response

Riley: Okay↓ so Lisa ↑i::s (.) a: 19 year old community
college student↓
Dave: =[Yeh]
Riley: [So:::] and again↓ (.) native English speaker:: (.) not
low SES (.) not attention-
So:: uh:: interesting (.) >A 19 year old in college<
(.) it must be: (.) I'm going to sa::y freshman year
like math 101 but they just have a remedial(¿) lesson
in things including fractions↓
Dave: =What is SES↓
Riley: =Good question↓
Dave: Hmm:: (1) No attention or behavioral issue↓ (.) And
then it's a college (.)
placement (.) test (.) placed her in a remedial
arithmetic class↓ (.) ↑which she failed↓
Riley: Let's ask ChatGPT↑
((Riley types into ChatGPT and waits for response)
Dave: =SAT scores not available↓ Mm hmm(¿)
Riley: (.) Ah (.) well (.) there's three we get↓ ChatGPT just
gave me three:: (.) Uh:: .hh
Interesting (.) I'm going to guess it's number three
>but we've got< Senior Executive Service (.)(hh)
>£She is not a manager of a company£<
Dave: [(hhh)]
Riley: She's:- (.) She's a 19 year old in college↓ (.)
Socioeconomic Status (.) I don't think
they'd measure [it as]-
Dave: [no]
Riley: =Yep (.) not low socioeconomic status or th[ey]-
Dave: [they got one]
Riley: <Special Education Services↓> (.) Tha:t makes
sense (.) ((reading from screen))
in the context of education↓ (.) SES may refer to
special education services provi:ded to students with
disabilities↓ So she::(¿)-
Dave: (.) But i: i: it's- it's also- also says that no attention or
behavioral issues were identified↓

In this excerpt (Excerpt #8), Riley and his partner Dave both encountered an acronym SES in their activity sheet, an unfamiliar term being used to describe Lisa. In Line 10, Dave posed the question to Riley, "What is SES?" Riley, first, confirmed receipt of the question "good question" in Line 11. Then, also unsure of the answer, he suggested in Line 16 that they prompt ChatGPT for it "Let's ask ChatGPT (Line 16)." This action to ask a question to ChatGPT is similar to Sam's utterance in Excerpt #6 (Let's see what the robot says). However, the difference is while Sam took what ChatGPT outputs in full, Riley negotiated and chose the meaning of SES among multiple options offscreen, Riley asked ChatGPT what SES meant to which ChatGPT responded with three potential considerations of what low SES might *M*: senior executive service, socioeconomic status, and special education services. Riley, responding to what ChatGPT has offered, considered each potential option aloud, concluding that SES must be Special Education Services as it seemed to make the most sense in relation to the context given in the activity sheet.

In this example, we can see how Riley, the main person giving prompt input to ChatGPT for this peer pair, is working alongside ChatGPT to define and interpret its responses, talking through the meaning of each possible acronym option (Lines 21–35). Rather than giving him (i.e., Riley) one single response, ChatGPT offered multiple answers which Riley had to further critique as to what makes the most sense for designing lesson plans. The epistemic stance fluctuates, with Riley and Dave initially taking a lower stance around the definition of an acronym of SES, but then adopting a higher epistemic stance on which of the returned answers is the right pedagogical term.

Another form of collaboration with ChatGPT is through asking a referential question through which teacher candidates were seeking additional confirmation or options beyond what they already have:

Excerpt #9. Building on the ideas of one another

Hally: ºThe ca.hhh:ptions I thinkº (11)
((reading from screen) >Students will understand the
concept of fractions through the real world example<
using pi::zza↓
Jake: (17) I like (.) the engagement↑(.) >Like asking about
their favorite toppings< (.)
I think that might (..) U::h (.) just >make them fee::l
comfortable↑< Like ha:ving (.) like a:: casual type of
discussion↑And >one of the< UDL:: (.) goals (.) was
ta (.) enable (.) students to take mathematical risks↓
(.) I think if the:y- (.) like if everyone has >shared a
little bit< about the kind of foo:d they like↑(.) Maybe
they will fee::l (.) comfortable in the classroom (.) and
willing to try:: new ideas ºand stuffº
Hally: Maybe a little more ((inaudible)) especially if they're
struggling with it
Jake: =Ye[ah]
Hally: [So] ((inaudible)) even if it's not related to math or
((inaudible))
Jake: [Right]
Jake: You can ask (.) who likes pineapple on pizza to like
(.) start a fight .hhh
Hally: =Yeah.
Jake: Get everyone real: into it

Excerpt #9 demonstrated how Jake and Hally built on the outputs from ChatGPT to align with their pedagogical content knowledge and enrich concepts of a fraction. Before this excerpt, Hally typed the following prompt to ChatGPT: "Design a lesson about fractions to build an understanding of adding fractions and common denomination, using pizza as an example." In Lines 2–4, Hally read the outputs from ChatGPT that confirm pizza can be a real-world example of teaching concepts. In Line 5, Jake swiftly connected ChatGPT's recommended pedagogical approach to one of the UDL principles, Engagement. Subsequently, Hally added her opinion that real-world examples in a mathematics classroom can facilitate student engagement. Jake echoed Hally's sentiment by saying a teacher can ask whether students like Hawaiian pizza (pineapple on pizza). In this example, we can see that Hally and Jake initially saw ChatGPT as being able to offer information.

However, by connecting their knowledge of UDL principles when interpreting the ChatGPT outputs, they created a moment of shared epistemic stance by adding a specific question that teachers can pose in a classroom setting. We also want to note that their focus was not on a continuous model of fractions that Lisa needs to learn (see an instructional guideline in the "Method" section). Instead, it was on a discrete set model (pizza). Therefore, although Excerpt #9 demonstrates collaboration between the teacher candidates and ChatGPT, the teacher candidates were unable to develop an adequate lesson plan for Lisa due to their lack of understanding of the difference between the continuous and discrete models.

Discussion

The Ways That Epistemic Stance Was Established

We applied Heritage's concept of epistemic stance to map the territories of knowledge that emerge during a lesson planning activity with ChatGPT. We explored how teacher candidates reveal an understanding of their territories of knowledge during the mathematics lesson planning process, and how these territories are negotiated in real-time conversational interactions with ChatGPT. This included looking at the types of questions (prompts) that teacher candidates asked to ChatGPT, and the teacher candidates' responses to ChatGPT outputs and their partners (evaluation, acceptance, or extended conversation to build more knowledge).

We found that teacher candidates' knowledge in mathematics education is reflected in how they organize turns, create prompts for ChatGPT, and decide whether to complete or extend turns to accept or request additional information. In our data, teacher candidates explicitly and constantly attempted to assess ChatGPT's territory of knowledge, which in turn gauged the epistemic status of AI. Unlike socially accepted general territories of knowledge across human interactions, human–ChatGPT territories of knowledge need to be surfaced, such as when teacher candidates took a higher epistemic stance (K+) than ChatGPT by posing display questions and checking the legitimacy of outputs from ChatGPT. In contrast, teacher candidates took a lower epistemic stance than ChatGPT for certain territories of knowledge by adopting referential questions, such as "Explain [X] to me."

An iterative pattern was that participants explicitly indicated whether they identified themselves as mathematics teachers or having mathematics knowledge for teaching, which relates to their epistemic status. They considered their professional identity and disciplinary domains in creating prompts for ChatGPT (Excerpts #2, #4, and #7). These findings suggest that educators' professional identities and territory of knowledge before engaging in interactions with ChatGPT continue to influence the ways that they positioned their epistemic stance during the interactions with ChatGPT. As Raymond and Heritage (2006) mentioned, disciplinary and professional identity was deeply intertwined with epistemic stance and its claims, and this tendency was also found when engaging with an AI-powered conversational agent.

Epistemic Gradients Between Teacher Candidates and ChatGPT

Recalling Heritage's (2012a) gradient model of epistemic stance, a steeper epistemic gradient slopes up between an unknowing questioner (K−) and a knowing recipient (K+) when the questioner has relatively limited knowledge of the topic. By contrast, when a questioner perceives that they have some claim to a territory of knowledge in relation to a recipient, the mapped slope is represented by either a more moderate or downward sloped line from K− to K+. Here, we categorized the five different epistemic gradients derived from the nine excerpts presented in our "Findings" section (see Figure 4).

Lines (a) and (b) indicate that a teacher candidate has a higher epistemic stance than ChatGPT, but with differing degrees of inclination. Excerpts #2 applies to Line (a), a steep downward slope where Nara positioned herself as already knowing how to teach mathematics and develop lesson plans before using ChatGPT, and decided *not* to solicit information from ChatGPT about creating lesson objectives. Line (b), a moderate downward slope, is applied to Excerpts #1 and #3 where both Sam and Nara positioned them as a person who can deny or confirm the validity of ChatGPT's output. In cases for both Lines (a) and (b), the teacher candidates had short or no negotiation with ChatGPT, gave concise responses (such as "wonderful"), and assumed their role of evaluator in the lesson planning activity.

Multiple occasions in Excerpts #4 through #7 where teacher candidates displayed a lower epistemic stance than ChatGPT can be represented as Lines (d) and (e) in Figure 4. A sharp upward slope (Line [e]) is where a teacher candidate posed an information-seeking question to ChatGPT such as "Explain it to me" in Excerpt #4 and "Let's see what the robot says" in Excerpt #6. Line (d), a moderate upward slope aligns with Excerpt #7 where Nara found a problem with her initial prompt ("oh") and then clarified her prompt before inputting it to ChatGPT. In cases for both Lines (d) and (e), the teacher candidate engaged in at least one more round of turn-taking to reflect on ChatGPT's output, and tweaked the prompt to request additional information from ChatGPT.

Our study also found evidence that symmetrical epistemic hierarchy between ChatGPT and teacher candidates (Line [c] in Figure 4) would be possible and potentially generative.

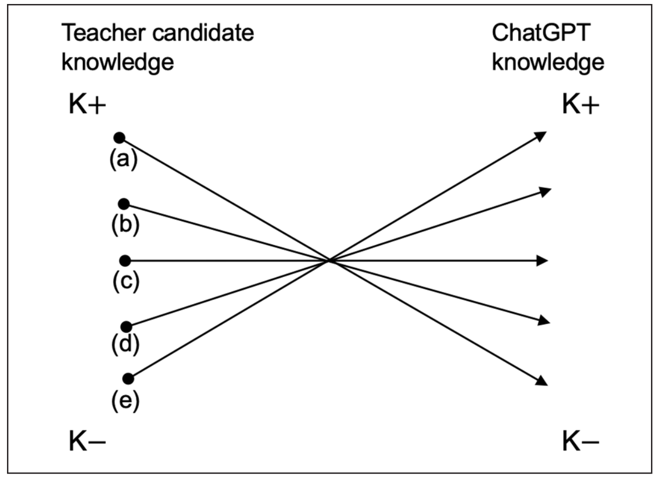


Figure 4. Representation of Epistemic Stance Types in the Nine Excerpts Shown in Our Findings (Adapted From Morales, 2021, Heritage, 2012a).

One example was when teacher candidates wanted to obtain information from ChatGPT that they did not know, and ChatGPT gave three possible options rather than landing on one absolute answer (Excerpt #9). Therefore, the teacher candidates used the ChatGPT output as a resource to explore possible answers and extend their thought. Similarly, another pair (Excerpt #9) also used the ChatGPT output to build their pedagogical approaches.

The dominant framing of ChatGPT use in education has often been based on binary thinking, such as whether ChatGPT provides accurate or false information (Hatmanto & Sari, 2023), and whether schools should ban students from using ChatGPT due to concerns that students may simply copy and paste its outputs. However, our analysis demonstrated the nuanced ways teachers take up ChatGPT's response. ChatGPT also generated outputs with multiple options that required teacher candidates to critically think about application and adoption. Teacher candidates subsequently unfolded ideas and made choices. This suggests that prompt curation can be taught to teacher candidates to ask ChatGPT to present multiple ideas, ensuring a more symmetrical epistemic stance that might be valuable for collaborative lesson planning. Teacher educators can also make use of teacher's explicit reasoning behind their choices of which option is used to assess their understandings of multiple aspects of content and pedagogy.

Our findings also showed how the epistemic stance that was captured through question posing and turn response shifted the roles of the speaker or recipient in the moments. Although some teacher candidates held a lower epistemic stance at the start of the dialogues, they rearranged their roles to evaluate the outputs, which allowed a higher epistemic stance. Recall that in Excerpts #3 and #5, Sam, although he said he was not a mathematics teacher, held a high epistemic stance by stating "(I will) choose the best one," and "I like the multiple means of representative assessment." These examples demonstrate that neither ChatGPT nor teacher candidates consistently held a higher epistemic stance throughout the dialogues, and the focus on turn-taking can reveal changes in the dynamics of epistemic stances. These interactions with ChatGPT seemed particularly valuable for some educators who are less confident in their mathematics teaching practices and lesson planning, as information provided through interactions with ChatGPT, including negotiations and assessment of responses, could build teacher candidates' confidence and competency.

The Importance of Teachers' Knowledge

Although we indicated what kinds of mathematics knowledge for teaching were addressed in the participating teacher candidates' discourses, our intention was not to test and draw conclusions of what kinds of mathematics knowledge for teaching were frequently used and why. Rather, we focused on how teacher candidates would position themselves when working with ChatGPT and how their mathematics knowledge for teaching would play a role in such positioning. Our study highlighted the critical role of teachers' knowledge in effectively using ChatGPT. We asked teacher candidates to develop a lesson plan on teaching fractions using the UDL framework for Lisa. Thus, we assumed that their lesson plans and interactions with ChatGPT would emphasize UDL teaching strategies (e.g., engagement, representation, strategic action; see Table 1), fraction concepts, and addressing Lisa's misunderstanding about adding fractions (misapplying a discrete set model to continuous models; see Figure 3) and student backgrounds (e.g., SES).

However, at times, participating teacher candidates were unable to curate relevant prompts or steer away from the conversations with ChatGPT due to their limited mathematics knowledge for teaching and their broader pedagogical knowledge (e.g., SES). For example, although some teacher candidates requested ChatGPT to provide clarification on mathematical concepts that they were not aware of (such as, the discrete set mode and continuous model, see Excerpt #4) before creating a mathematics activity, others did not (Excerpt #9). Therefore, they created a mathematics activity focusing on a discrete model, instead of the continuous model that Lisa needed to understand. In addition, some teacher candidates (Riley and Dave) misinterpreted the term SES (socioeconomic status) as special education services (see Excerpt #8), a term which their instructor assumed that the teacher candidates already knew.

These findings suggest that teacher educators need to provide ample support for teacher candidates regarding mathematics knowledge for teaching before and during engaging in lesson planning with ChatGPT. One example is related to specialized content knowledge, mathematics knowledge uniquely needed for teaching fractions. If a teacher educator had explicitly taught the difference between a continuous model of fractions and a discrete model of fractions, teacher candidates could have better articulated the pedagogical approaches needed to develop a lesson plan for Lisa. Regarding pedagogical content knowledge, while some teacher candidates asked the meaning of UDL to ChatGPT, they rarely inquired about specific teaching strategies for implementing UDL, possibly because they may not be fully aware of the importance of teaching strategies in mathematics instruction. Teacher educators could explicitly inform the importance of teaching strategy and work with ChatGPT to expand their ideas. As briefly discussed above, it is crucial for teacher educators to create opportunities for teacher candidates to assess their current levels in the mathematics knowledge for teaching domains, help them develop the ability to critically evaluate ChatGPT's outputs, and request relevant information from ChatGPT to effectively address lesson objectives.

Overall, this study demonstrated how Heritage's gradient model of epistemic stance could be mobilized to reveal how teacher candidates would position themselves while working with ChatGPT. Thus, our approach was different from previous studies on ChatGPT applications in teacher education where the focus turns to the effectiveness of ChatGPT, such as whether it provides false information or how student achievement increased when ChatGPT-created lesson plans were used (Hatmanto & Sari, 2023). Our study extends this conversation by emphasizing how teacher candidates' epistemic stance was displayed in lesson planning with ChatGPT and how they agentically curated their discursive moves, including the possibilities that emerge from such dialogic dynamics.

Limitations

We acknowledge the limitation of using data from a single teacher education course activity. This study was limited to teacher candidates from one U.S. college, analyzing their interactions with ChatGPT while curating a lesson plan. Although a typical population for the particular context is under study, the background factors (e.g., teaching experience and AI familiarity) will likely differ from other contexts. Therefore, readers should exercise caution when interpreting and applying these results.

As Bisconti et al. (2024) note, "it is necessary to formulate a new system level framework that acknowledges the role of AI as social actors but that further understands these programs as technologies that are always situated within human social environments" (p. 6). The research methods and theoretical framework used in this study can inform researchers interested in understanding nuances of teacher candidates' interaction with AI.

Conclusion

Using ChatGPT is not the only way for lesson planning. Teacher candidates have access to various resources for developing effective lesson plans. However, ChatGPT provides a valuable and increasingly common opportunity to gain access to unknown information and verify knowledge teacher candidates already possess. Our study found that teacher candidates adopted both higher and lower epistemic stances when using ChatGPT, shaped by their professional identity and mathematics knowledge for teaching. In addition, our study found that when ChatGPT provided various options that teacher candidates could choose, a symmetric epistemic hierarchy was formed. Therefore, teacher educators can modify activity instructions to provide teacher candidates with a variety of choices, requiring them to explain their selections and the reasoning behind their decisions. Consistent with research on teachers' use of technology (Voogt et al., 2013), this suggests that educators need sufficient knowledge to request information, evaluate outputs, and seek further details from ChatGPT. It also implies the risk that teachers may accept inaccurate information from ChatGPT if there are gaps in knowledge. This uptake of misinformation from ChatGPT can also help teachers identify and address gaps in understanding. Therefore, teacher education programs should not only focus on how to integrate generative AI conversation agents into the mathematics classroom but also emphasize the development of mathematics knowledge for teaching, including subject matter knowledge and pedagogical content knowledge.

Recommendations

AI is increasingly finding a way into higher education classrooms. Policies across many universities now advocate for the addition of language around AI use in syllabi. This study recommends a nuanced engagement with the *how* of AI use rather than a universal rejection. Teacher educators may consider the conclusions from this study when designing lessons in which teacher candidates use ChatGPT to develop educational materials.

Future empirical research is needed to explore the interaction between teacher candidates and generative AI across other mathematical domains. In addition, future studies can investigate the impact of the territories of knowledge on the epistemic stance of teacher candidates in other subject areas with different AI tools. Furthermore, more research is necessary to assess what policies and practices in teacher education can help teacher candidates to use other generative AI in a way to broaden their territories of knowledge.

Appendix A

Lesson Plan Template

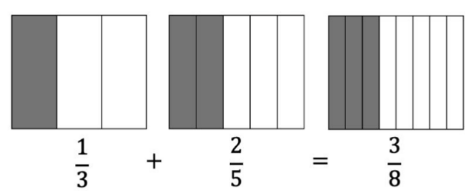
1-a. CCSSM

5.NF.A. Use equivalent fractions as a strategy to add and subtract fractions:

1. Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators.
2. Solve word problems involving addition and subtraction of fractions referring to the same whole (the whole can be a set of objects), including cases of unlike denominators, for example, using visual fraction models or equations to represent the problem. Use benchmark fractions and number sense of fractions to estimate mentally and assess the reasonableness of answers. For example, recognize an incorrect result $2/5 + 1/2 = 3/7$, by observing that $3/7 < 1/2$

1-b. Context:

Below is how Lisa solves a fraction addition problem. When interpreting or manipulating fractional representations, Lisa often overapplied a discrete set model to continuous models in which she ignored the size of the parts and treated all parts as if they were interchangeable.



Create a mathematics lesson plan to support her approach to fraction addition. Lisa is a 19-year old community college student who is assigned to a remedial mathematics class, native English speaker, not low SES, and has no attention or behavior issues.

1-c. Content Objective(s):

Objectives should be inclusive and accessible, and cross-cutting. Objectives should also be singular, measurable, and aligned to lesson procedure and assessment. You should have two to three objectives for your lesson that reflect UDL.

Objective 1.
Objective 2.
Objective 3.

1-d. Evidence and Assessment:

How will you measure student progress toward objectives? What evidence will show student progress and how is equitable assessment reflected?

1-e. Materials:

- Your materials should be accessible and use principles of UDL.
- Indicate within your lesson procedure where you will use each material.
- Think purposefully about materials and how they are linked to three principles of UDL.

1-f. Lesson Procedure:

- Your lesson procedure should detail each step of the lesson and interrogate barriers, structures, and systems that may prevent Lisa from full participation.
- Explicitly note incorporation of UDL principles in your steps.
- Consider the profile of Lisa stated in the pdf file.

Lesson Aspect	Materials Used	Barriers, structures, or systems that may prevent full student participation	Description of how principles of UDL/ democratic education are addressed (as needed—not necessarily in every step).

1-g. Detailed description of how you are going to implement this lesson.

Appendix B

Questions Included in a Post-Activity Reflection Journal

The educators submitted post-activity reflections to the following five questions: (a) What connections do you see between UDL and mathematics? (b) Was ChatGPT useful for helping you to complete the UDL mathematics lesson plan design? Please give your reasons. (c) What difficulties did you encounter when you used ChatGPT to complete the UDL mathematics lesson plan design? How did you solve them? (d) Did you use any tools or resources when interacting with ChatGPT and performing the UDL mathematics lesson design task? If yes, what were they and why did you use them? and (e) Share any thoughts or comments if you want to.

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Authors did not use generative AI to write our manuscript.

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Note

1. UDL is an "approach to pedagogy, curriculum, and assessment grounded in the learning sciences and neuroscience" (Meyer et al., 2014, as cited in the work by Lambert, 2021, p. 661). This approach understands disability as affected by context and focuses on changing learning environments to meet the diverse needs of learners.

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