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'Boring' or 'Fun': Pre-Service Middle School Mathematics Teachers' Epistemological and Positional Framing of Mathematics, Its Learning and Teaching

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Abstract: Pre-service mathematics teachers' conceptions of mathematics and their positioning as future teachers provide insight into how they frame mathematics teaching and learning. This study examines the epistemological and positional framing of 19 pre-service middle school mathematics teachers enrolled in a mathematics methods course at a university situated in a U.S.-Mexico border region. Drawing on Hammer and Elby's (2002, 2003) epistemological resources framework and Harré and van Langenhove's (1999) positioning theory, we analyzed participants' written responses to four purposefully designed prompts that probed their beliefs about the nature of mathematics and their instructional strategies for making mathematics accessible and engaging. Thematic analysis, conducted by three raters (percentage agreement 75%), generated themes for epistemological framing (e.g., teacher and teaching, student experience, learning process, and content characteristics) and positional framing (e. g., instructional strategies, real-life relevance, manipulatives and visuals, technology integration and gamification, and collaboration and social learning). Findings reveal that the large majority of participants (12/19) rejected a deficit framing of mathematics as inherently difficult and boring, while simultaneously resisting the opposite extreme of reducing mathematics to mere fun and simplicity. Rather, participants consistently sought to integrate engagement, conceptual rigor, and real-world relevance - reflecting a nuanced epistemological stance that treats mathematical challenge and student motivation as complementary rather than competing demands. These findings carry significant implications for mathematics teacher education, underscoring the need to develop future teachers' explicit, integrated awareness of both what mathematics is and how it is enacted in the classroom.

Keywords: epistemological framing, middle school mathematics, positional framing, pre-service mathematics teachers, teacher education.
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Introduction: Two Lenses on Knowing

How teachers relate to mathematical knowledge has never been a simple matter of cognitive access. It is simultaneously a matter of belief, identity, and framing. Over the past three decades, mathematics education research has developed two partially overlapping yet competing frameworks for understanding these dynamics: epistemological framing and positional framing. Both constructs attend the question of how participants make sense of what they are doing and why - but they do so by foregrounding different dimensions of sense-making. Epistemological framing focuses on teachers' implicit orientations toward knowledge itself: what counts as knowing, and what is the nature of mathematics (e.g., 'mathematics is boring' or 'mathematics is fun'). Positional framing focuses on the relational, social dimension: how mathematics is enacted in the learning and teaching context (e.g., ‘how to make mathematics fun’).

These two frameworks have developed largely in parallel - the epistemological framing tradition rooted in cognitive science and education research (Delahunty & Kimbell, 2021; Elby & Hammer, 2010; Hammer & Elby, 2002, 2003), and the positional framing tradition rooted in social psychology and discursive analysis (Harré & van Langenhove, 1999; Herbel-Eisenmann & Wagner, 2010; Russ & Luna, 2013; Wagner & Herbel-Eisenmann, 2009). Only recently has sustained work in mathematics education research begun to theorize its interaction and interdependence (Alvidrez et al., 2024; Shim & Kim, 2018).

The primary purpose of this project is to study the enactment of epistemological and positional framing in the context of pre-service middle school mathematics teachers’ (PSMTs) responses to the given prompts. This study follows a qualitative method design and focuses on the major themes emerging from PSMT’s reactions to different epistemological frames (e.g., ‘mathematics is difficult and boring’ vs. ‘mathematics is easy and fun’) and positional frames (e.g., ‘how to make mathematics easy and fun’). The study responds to the research gap in the literature on theorizing interaction and interdependence between teachers’ epistemological and positional framing regarding the nature of mathematics, its learning, and teaching. Therefore, the study attempts to address the following research questions:

1. What are pre-service middle school mathematics teachers’ reactions to different epistemological frames on the nature of mathematics?
2. How do pre-service middle school mathematics teachers contextualize their positional framing in learning and understanding a topic-specific concept?

Next, we trace the intellectual origins of each tradition (e.g., epistemological and positional framing), analyze the theoretical differences and productive tensions between them, survey key empirical findings, and argue for an integrated, dialectical approach to framing research in mathematics education.

Theoretical Framework

Epistemological Framing: Core Claims

The epistemological framing tradition emerged in the 1990s, when Hammer and colleagues grew dissatisfied with prevailing accounts of students' beliefs about knowledge. Earlier research in the Hofer–Pintrich tradition (1997) had treated epistemological beliefs as relatively stable orientations - students either believed knowledge was certain or tentative, simple or complex, handed down by authority or personally constructed. Hammer and Elby (2002) challenged this unitary assumption, arguing that epistemological orientations are better understood as fine-grained, context-sensitive resources that can be differently activated depending on the situation.

The framing concept itself draws explicitly on Goffman (1974) and Tannen (1993), treating frames not as internal mental states but as contextually embedded expectations about the nature of the activity at hand. This is a crucial move: it shifts the unit of analysis from the individual's stable beliefs to the dynamic situation in which those beliefs are activated. As Hammer et al. (2005) articulate, a student's frame shapes not just what they think but what they notice, how they act, and what they consider relevant or irrelevant. Two students sitting in the same classroom, facing the same problem, can be in radically different epistemological frames - one treating the task as a boring exercise in applying memorized procedures, another treating it as a fun puzzle whose solution requires sense-making.

In mathematics education, epistemological framing research has been applied primarily to three questions. First, what frames do students characteristically bring to mathematics classrooms, and how do those frames shape what they learn? Research consistently shows that many students, particularly in procedurally oriented classrooms, default to an 'answer-getting' frame in which mathematics is understood as a collection of algorithmic procedures to be reproduced rather than ideas to be understood (Boaler, 2016; Schoenfeld, 1992). Second, how do instructional contexts cue out particular epistemological frames? Engle and Conant (2002), working from a situative perspective, argue that the design of classroom activities positions students as either recipients of information or as active participants in disciplinary inquiry - a framing difference with profound consequences for engagement and learning. Third, how can teachers shift students toward more productive frames? Hammer and Elby (2003) argue that teachers who understand framing as a resource-activation phenomenon - rather than as a deficit of student belief - are better positioned to respond to students' framing in ways that leverage their existing epistemic resources rather than bypassing them.

Recent research has continued to extend the application of epistemological framing across educational contexts. Wendell et al. (2019) examined novice elementary teachers’ epistemological framings during engineering design activities, highlighting how teachers’ implicit epistemological ideas shaped their approaches to learning and teaching. In addition, recent studies have examined the dynamic and context-dependent nature of epistemological framing by investigating how students activate epistemological resources during disciplinary sensemaking (Patterson & Ding, 2025) and how epistemological and positional framings interact during collaborative learning activities (Kaur & Dasgupta, 2024). Together, these studies demonstrate the continued relevance of epistemological framing as a lens for understanding how learners and teachers interpret and engage in educational activities.

Positional Framing: Main Assumptions

Positional framing has its intellectual roots in Harré and van Langenhove's positioning theory (1999), which emerged as a critique of role theory in social psychology. Where role theory treats social behavior as the enactment of pre-given scripts attached to static positions (teacher, student, expert, novice), positioning theory attends the moment-to-moment, discursive negotiation and interaction. A position in this framework is not a fixed social identity but a dynamic assignment. These assignments are enacted through what positioning theorists call 'communication acts' that unfold within 'storylines' (oral or written) - culturally familiar narratives that give an episode its social and contextual structure.

Wagner and Herbel-Eisenmann (2009) introduced positioning theory to mathematics education research through their influential paper 'Re-mythologizing mathematics through attention to classroom positioning.' They argued that dominant storylines in mathematics classrooms - storylines in which mathematics is presented as a fixed body of certain truths, the teacher as sole arbiter of correctness, and students as passive recipients of knowledge - systematically constrain the positions available to students. These storylines, they contend, are not politically neutral: they reproduce existing hierarchies of mathematical authority and work against the development of students' agency and voice.

The power of positional framing as an analytical lens lies in its attention to granular interactional data: who uses the pronoun 'we' versus 'you,' who initiates topic changes, whose contributions are taken up and whose are deflected, and how the textbook is linguistically positioned as an authority or as a resource (Herbel-Eisenmann & Wagner, 2007). This micro-level attention reveals patterns of inclusion and exclusion that macro-level accounts of 'classroom culture' tend to miss. Research using positioning theory has documented how teachers' language choices can position students as capable mathematical thinkers or as objects of correction; how students position themselves and each other as competent or incompetent; how multilingual learners are systematically positioned at the margins of mathematical participation; and how even reform-oriented teachers can inadvertently reproduce hierarchical positional structures in the act of trying to dismantle them (Domínguez, 2011; Smith, 2024).

In mathematics teacher education, positional framing research has focused on what Herbel-Eisenmann and Otten (2011) call 'authority structures' in classroom discourse - the implicit agreements about who has the right to validate mathematical truth. They distinguish between the teacher's personal mathematical authority, the authority of the textbook, and the authority of mathematical reasoning itself, showing how these different authority sources create different positional possibilities for students. A classroom in which mathematical authority resides primarily in the teacher or the textbook positions students as passive recipients; a classroom in which authority resides in reasoning and argumentation positions them as participants in a mathematical community of practice.

Recent research has continued to apply positional framing within teacher education contexts. Kurup et al. (2023) examined epistemological and positional framing among pre-service teachers participating in an international practicum, highlighting how framing processes shaped participants' interpretations of teaching experiences within collaborative and culturally diverse contexts. Similarly, Alvidrez et al. (2024) examined mathematics teachers' epistemological and positional framing of mistakes, illustrating how teachers' framing of errors communicated expectations regarding students' roles and participation in mathematical activity.

Theoretical Differences and Productive Tensions

The two frameworks share a common ancestor in Goffman's frame analysis (1974) and a common rejection of the idea that classroom behavior is simply determined by cognitive competence. Both attend context-dependence, dynamic situatedness, and the idea that what appears as a stable disposition may in fact be the product of moment-by-moment activation. Beyond these shared commitments, however, they diverge sharply.

The most fundamental difference is ontological. Epistemological framing is primarily a cognitive framework: its unit of analysis is the individual mind, specifically the activation pattern of epistemological resources within a given learner. Even when epistemological framing is studied in social settings, the phenomenon of interest is how the individual student or teacher is oriented toward knowledge. Positional framing, by contrast, is fundamentally a social and discursive framework: its unit of analysis is the interactive episode, specifically the negotiation of rights and duties among participants. The individual matters in positioning theory only as a node in a web of social relations, not as a locus of cognitive processing.

This ontological difference ramifies into different empirical sensitivities. Epistemological framing research is particularly attuned to what students think mathematics is and what it is for, what counts as a legitimate mathematical justification, and whether students approach problems as ‘fun’ puzzles to be figured out or ‘boring’ routines to be executed. It can explain why a mathematically capable student suddenly becomes confused when the activity is framed as a quiz rather than an exploration, or why the same student who reasons flexibly in conversation with peers reproduces memorized algorithms when called upon by the teacher. Positional framing research, by contrast, is particularly attuned to how learning and teaching happen in the classroom, who speaks and who listens, whose ideas are taken up and whose are dismissed, and how the authority of the teacher intersects with or overrides the epistemic authority of student reasoning.

A second difference concerns the relationship between framing and identity. In the epistemological framing tradition, identity is largely implicit: the question of how a student frames mathematics is not typically connected to questions of who the student is or who they aspire to be as a mathematical learner. In the positional framing tradition, identity is central: to be positioned as a capable or incapable mathematician is to have one's mathematical identity simultaneously affirmed or denied. This is not merely a question of momentary effect but of longer-term trajectory - students who are repeatedly positioned as incapable in mathematics classrooms accumulate a history of marginalization that shapes both their willingness to persist and their sense of belonging (Aguirre et al., 2013; Gresalfi & Cobb, 2006).

Third, the two frameworks carry different implications for teacher practice. Epistemological framing theory tends to direct teachers' attention to the nature of mathematics, to the intellectual texture of mathematical tasks and their discourse: Are the tasks designed to invite sense-making or procedure-following? Are the teachers’ questions genuinely open or rhetorically closed? Does the classroom culture reward mathematical reasoning or correct-answer production? Positional framing theory directs teachers' attention to the relational texture of classroom interaction:

How do I structure classroom learning? How do I make mathematics fun and easy to understand? Whose contributions am I taking up? What storylines am I invoking, and what positions do they make available to different groups of students?

These different emphases can generate conflicting practical recommendations. A teacher working from an epistemological framing perspective might redesign a task to be more genuinely open-ended and conceptually demanding, believing this will invite more productive student engagement. A researcher working from a positional framing perspective might observe that the redesigned task, while intellectually richer, is being implemented in a way that still concentrates epistemic authority in the teacher - because the teacher is evaluating student responses against an implicit standard rather than positioning students as active mathematical authorities. The same classroom action can be productive from one lens and problematic from the other.

Integration of Framing

The most generative development in recent framing research is the growing attention to how epistemological and positional frames co-determine each other. Shim and Kim's (2018) study of eighth-grade Korean students engaged in modeling is particularly instructive. They show that students' epistemological frames - their orientations toward what the modeling activity was for - were shaped in real time by the positional dynamics within the group: who was positioned as having epistemic authority shaped what the group collectively treated as valid knowledge-making activity. Conversely, shifts in epistemological framing - when students began to treat the task as genuinely open rather than as an exercise with a predetermined answer - also shifted positional dynamics, opening space for previously marginalized voices.

Alvidrez et al. (2024) study of how secondary mathematics teachers frame student errors is perhaps the most direct empirical treatment of the interaction between the two forms of framing. They identify four primary frames that teachers invoked around mathematical mistakes: two epistemological (errors-as-resources; errors-as-deficiencies) and two positional (students-as-capable; students-as-incapable). Their central finding challenges the intuitive assumption that teachers with productive epistemological beliefs - who see errors as resources for learning - will automatically adopt productive positional stances toward their students. In practice, the relationship between epistemological and positional framing is complex: a teacher can frame errors epistemologically as valuable opportunities for mathematical insight while simultaneously framing the student who made the error positionally as incapable, or conversely, can frame students as capable learners while simultaneously treating errors as deficiencies to be corrected rather than resources to be explored.

This finding has significant implications for mathematics teacher education. It suggests that professional development focused exclusively on changing teachers' epistemological beliefs - persuading them, for instance, that mistakes are valuable for learning - will not automatically produce more equitable classroom interactions if positional dynamics are left unexamined. Teachers need not only new epistemological orientations toward mathematical knowledge but also sustained attention to the positional stories they tell about their students through the micro-level choices of classroom discourse.

The theoretical synthesis that emerges from this empirical work is not simply additive - it is not a matter of combining two frameworks by listing their respective insights side by side. Rather, it suggests that epistemological and positional frames are dialectically related: the distribution of epistemic authority in a classroom (a positional question) shapes the kind of sense-making activity students engage in (an epistemological question), and conversely, what students and teachers implicitly believe sense-making involves (an epistemological question) shapes the social roles that become available and desirable in the classroom (a positional question). Neither dimension is more fundamental; neither is reducible to the other.

This dialectical relationship has deep roots in the history of mathematics education theory. Yackel and Cobb's (1996) foundational work on socio-mathematical norms identified a related dynamic: the norms that govern what counts as a mathematically acceptable explanation, a sophisticated argument, or an efficient solution are simultaneously epistemological (they define mathematical quality) and positional (they grant differential status to different students and different kinds of contribution). More recently, Sfard's (2008) commognitive framework provides a theoretical architecture in which epistemological and positional dimensions are formally integrated: mathematical discourse is simultaneously a way of doing mathematics (epistemological) and a way of positioning oneself and others within a community of mathematical practice (positional). In Sfard's account, learning mathematics is not merely to acquire new cognitive structures but to change one's participatory patterns in mathematical discourse - a change that is irreducibly both cognitive and social.

This study examined pre-service middle school mathematics teachers' epistemological and positional framing using purposefully designed prompts and further analyzed teachers' responses to discuss the integration of frames using qualitative methods. In the next section, we briefly outline the design of the study, describe participants, present the data source (e.g., prompts), and data collection as well as data analysis techniques.

Methods

This study employed a qualitative research design to explore pre-service teachers' framing of mathematics, its learning, and teaching. The study focused on participants' written responses to a set of prompts related to the nature of mathematics, its learning, and the teaching of a challenging topic such as the division of fractions.

Participants

The participants in this study were 19 pre-service middle school mathematics teachers (PSMTs). All participants took part in an online discussion forum as part of a course of activity. Their responses provided insights into the way they frame mathematics, its learning and teaching as well as the role of engagement with mathematics, and strategies for teaching challenging mathematical concepts.

Out of 19 participants, by ethnicity criterion: the majority (16 participants) were Hispanics, reflecting the demographics of the region, and 3 were white. Additionally, the cohort reflected a gender distribution of 15 females and 4 males. All participants were enrolled in a mathematics method course at a university situated in a U.S.-Mexico border region, a context characterized by ongoing cross-cultural exchange. This setting often involves bilingual practices, diverse educational backgrounds, and hybrid cultural perspectives. Although the study was conducted in a bilingual, Hispanic-majority U.S.–Mexico border context, language and cultural identity were not examined as analytic variables. They are presented to contextualize the setting in which participants' responses were generated.

Data Collection

Data were collected through an online discussion forum in which participants responded to four prompts related to mathematics, its learning, and teaching. The prompts asked participants to reflect on the following four questions:

1. Some people consider mathematics a difficult and boring subject. Do you agree with this statement? Why or why not?
2. Some people think that mathematics is easy and fun. Do you agree with this statement? Why or why not?
3. How would you make mathematics easy and fun to learn and understand? Be specific, please.
4. The division of fractions is considered a difficult topic in the middle school curriculum. How would you make this topic easy and fun to learn and understand? Provide details, please.

The rationale for selecting prompts is threefold. First, they indirectly probe teachers' frames. Second, the first two prompts provide teachers with a choice of testing different epistemological frames (e.g., 'mathematics is difficult and boring' and 'mathematics is easy and fun') with options of agreeing or disagreeing. Third, the process of prompt selection was closely informed by research questions and the theoretical framework as presented in Table 1.

Table 1

Connection Between Research Questions, Framing, and Prompts

Research Question	Prompt	Framing	Perspective
What are pre-service middle school mathematics teachers' reactions to different epistemological frames on the nature of mathematics?	Some people consider mathematics a difficult and boring subject. Do you agree with this statement? Why or why not?	Epistemological	Nature of Mathematics
	Some people think that mathematics is easy and fun. Do you agree with this statement? Why or why not?	Epistemological	Nature of Mathematics
How do pre-service middle school mathematics teachers contextualize their	How would you make mathematics easy and fun to learn and understand? Be specific, please.	Positional	Mathematics Learning and Teaching General

positional framing in learning and understanding a topic-specific concept?	The division of fractions is considered a difficult topic in the middle school curriculum. How would you make this topic easy and fun to learn and understand? Provide details, please.	Positional	Mathematics Learning and Teaching Contextual (topic-specific)

Even though the table delineates the research questions and prompts the type of framing (epistemological and positional), in the analysis of teachers' responses, we observed integration of framing (see section 2.4). To emphasize the positional framing as well as to illustrate the integration of frames, we also used the discussion board postings (where participants reacted to each other's responses to prompts) as an additional source of data (an example of the discussion board posting is included in Appendix C).

Research Positionality

The research team consisted of three doctoral students and one faculty member with expertise in mathematics teaching. The doctoral students brought experience in mathematics teaching and teacher preparation, while the faculty member contributed his extensive expertise in mathematics education. The researchers acknowledge that their backgrounds and experiences may influence the interpretation of participants' responses. Their collective knowledge of mathematics teaching and teacher preparation provided a contextual lens for interpreting participants' perspectives on the nature of mathematics and mathematics instruction.

Data Analysis

The collected data were analyzed using an inductive qualitative coding process informed by Saldaña (2013). The four writing prompts served as the organizational structure for organizing the analysis, with responses to each prompt analyzed separately. Rather than applying a predetermined set of codes, the researchers generated codes directly from participants' written responses as meaningful ideas and patterns emerged from the data.

A coded segment was defined as the smallest meaningful unit of text expressing a single central idea relevant to the research questions. Depending on the participant's response, a coded segment could consist of a word, phrase, clause, or sentence. When participants expressed multiple distinct ideas within a single response, each idea was segmented and coded separately. This approach allowed a single participant response to generate multiple coded segments.

Three researchers independently coded all coded segments. As the analysis progressed, the codebook was developed iteratively, with new codes added whenever participants expressed concepts that were not adequately represented by the existing coding framework. Operational definitions were refined throughout the coding process to maintain consistency in the application of codes across the dataset. After the initial coding process, related codes were organized into broader analytic categories that captured shared meanings across participants' responses. These categories were then synthesized into themes representing recurring patterns in participants' responses. The identified themes were subsequently used to interpret participants' epistemological and positional framing of mathematics, mathematics instruction, and instructional approaches for supporting students' understanding of fraction division.

Intercoder agreement across the three coders was calculated by the percentage agreement (75%), indicating acceptable agreement for educational research (Hill et al., 2008). Following the independent coding process, a fourth researcher independently reviewed coding discrepancies and established the final coding decisions for each coded segment. The finalized coding was then used to develop the thematic themes presented in the results. These procedures were implemented to strengthen the consistency and credibility of the qualitative analysis. To increase methodological transparency, Appendix A provides a representative example of the coding process, illustrating how one of the participants' (we used a pseudonym Enzo) responses was segmented into meaningful units, assigned initial codes, subsequently organized into broader analytic categories, and, finally, extracted major categories.

Following the thematic analysis of each prompt, participants' responses across all four prompts were examined holistically to explore the relationship between epistemological and positional framing at the individual level. For each participant, an analytic profile was developed that synthesized (a) their epistemological framing of mathematics (Prompts 1–2), (b) their positional framing as future teachers (Prompts 3–4), and (c) the relationship between these two framings. This cross-prompt analysis was used to examine the coherence between participants' frames as presented in Appendix B.

Results

In this section, we present and discuss the main findings of the study based on participants' responses to the four writing prompts. The coded segments identified during the analysis were organized into broader themes representing recurring patterns across participants' responses. These themes informed the interpretation of participants' epistemological and positional framing of mathematics and mathematics instruction. First, we present findings from Prompts 1 and 2, which examined participants' views of the nature of mathematics. We then present findings from Prompts 3 and 4, which focused on how participants positioned themselves as future teachers and described approaches for making mathematics accessible and engaging. Finally, we present an integrated cross-prompt analysis examining the relationship between participants' epistemological and positional framing at the individual level.

Epistemological Framing: Mathematics is a Difficult and Boring Subject

Participants' responses to this prompt primarily reflect epistemological framing, as they articulate beliefs about the nature of mathematics as a discipline, particularly whether it is inherently "boring" or "difficult." In response to Prompt 1, "Some people consider mathematics to be a difficult and boring subject. Do you agree with this statement? Why or why not?”, the majority of the 19 participants rejected the statement: 13 disagreed, 4 expressed partial agreement or disagreement, and 2 did not directly address the statement. This distribution indicates that most pre-service mathematics teachers did not describe mathematics as inherently difficult or boring. Responses that expressed partial agreement or alternative perspectives provided additional insight into how participants conceptualized the nature of mathematics and students’ experiences with the subject. This interplay becomes more visible in the thematic analysis of participants’ responses. A total of 178 coded segments were identified across participants’ responses. The analysis generated four main themes: Teacher and teaching (n=39), student experience (n=92), learning process (n=30), and content characteristics (n=17). These themes, each comprising multiple categories, reflect different ways in which participants constructed the nature of mathematics and what it means to know and experience it, rather than representing independent factors.

Teacher and Teaching

The theme of teacher and teaching accounted for 39 coded segments and included four categories: Teaching methods and styles (n=13), Teachers' influence (n=14), Instructional strategies (n=7), and Engagement techniques (n=5). Responses within the Teaching methods and styles category highlighted teaching approaches as influential factors in shaping students’ experiences with mathematics. Participants frequently described traditional and procedural approaches as limiting students’ engagement and understanding. For example, one participant explained that “the main reason some students find mathematics difficult and boring is because in school we are just taught to follow steps to obtain an answer.” Similarly, another participant described mathematics instruction as occurring “in a traditional manner that does not allow for creativity and making connections,” emphasizing the perceived limitations of approaches centered on procedures rather than meaning making.

The Teachers' influence category reflected participants’ views of teachers as important contributors to students’ attitudes toward mathematics. Participants emphasized that teachers’ knowledge, passion, and instructional approaches can shape how students experience the subject. One participant stated, “I do not agree with the statement that math is boring and difficult. I believe math can be one of the most fun and entertaining subjects, if it is taught by the right teacher.” Another participant reinforced this perspective by explaining, “students remember a teacher who has passion and knows how to teach,” highlighting the role of teachers in influencing students’ perceptions of mathematics.

The Instructional strategies category included responses emphasizing differentiated instruction, practical application, and modifications to support diverse learners, suggesting that mathematics can be framed as meaningful and enjoyable when instruction moves beyond procedural delivery. Finally, the Engagement techniques category included responses describing how interactive exercises, engaging materials, and entertaining content can make mathematics more enjoyable. Together, these responses illustrate that participants framed teaching practices as central to how mathematics is experienced by students.

Student Experience

This theme comprised 92 coded segments and four categories: Affective and motivational factors (n=52), Relevance and connection (n=19), Individual factors (n=5), and Perception of mathematics (n=16). Participants framed mathematics largely through students' emotional and motivational experiences, suggesting that how mathematics is perceived depends on how it is experienced by learners. Within the Affective and motivational factors category, participants frequently described mathematics as engaging when students experienced success and enjoyment. For example, one participant stated that "math can be one of the most interesting and entertaining subjects if one is able to see its real-world implications," while another explained that "if we make math exciting and meaningful by providing opportunities for real-world connections, exploration, creativity, and varied instruction, we might be able to change a student's opinion of math being boring and difficult." The Relevance and connection category further emphasized the importance of linking mathematics to meaningful, real-world contexts. Participants also recognized Individual factors, noting that "throughout my educational observations and experience I see students enthusiasm once they understand a topic" and that instruction should be adapted because "you should present topics in different ways, this will allow to tailor instruction to different learning styles." Finally, the Perception of mathematics category reflected participants' views that students' beliefs about mathematics are shaped by these affective, contextual, and individual experiences rather than by the subject itself.

Learning Process

This theme included 30 coded segments and comprised three categories: Cognitive processes (n=13), Conceptual understanding (n=7), and Practice and effort (n=10). Participants described mathematics learning as involving active cognitive engagement, conceptual development, and sustained effort. The Cognitive processes category reflected participants' views of mathematics as a discipline that involves problem-solving, critical thinking, creativity, exploration, and logical reasoning. Participants described mathematics as a process of making sense of problems and applying reasoning to develop solutions. The Conceptual understanding category highlighted the importance of developing meaning and connections among mathematical ideas. Participants emphasized that mathematics requires more than following procedures, noting the importance of understanding concepts and making connections. For example, one participant explained that mathematics can become difficult when students are unable to understand the underlying ideas behind mathematical processes.

The Practice and effort category captured participants' recognition that learning mathematics requires persistence, time, and continued practice. Participants described mathematical development as a process that involves effort and sustained engagement. One participant explained that "math can get difficult because it requires work; performing math, especially as the grade levels move up, involves many multi-step processes to solve problems." Another participant noted that "being able to master it takes a lot more practice than it does with other subjects," adding that boredom may occur when students repeatedly complete "the same steps with different numbers." These responses indicate that participants associate mathematical difficulty not only with the complexity of the subject, but also with the effort and persistence required to develop mathematical understanding.

Content Characteristics

The content characteristics theme included 17 coded segments and included two categories: Difficulty level (n=10) and Simplicity or ease (n=7). Participants describe mathematics as a subject that can involve challenges while also becoming accessible under certain learning conditions. Some participants emphasized the effort and complexity involved in learning mathematics, while others described experiences in which mathematical processes felt more straightforward. For example, one participant explained that mathematics can become difficult when students experience “the traditional non-engaging way where it is teacher-centered, making it harder for us to understand and boring at the same time.” Another participant shared, “I enjoy seeking the right answers, and I find it easy to just plug in numbers into a formula, especially Algebra.” These responses reflect varied ways participants conceptualized mathematics in relation to difficulty and accessibility.

Epistemological Framing in Transition: Mathematics is Easy and Fun

In response to Prompt 2, “Some people think that teaching mathematics should be easy and fun. Do you agree with this statement? Why or why not?”, responses across the 19 participants showed considerable variation: 8 participants explicitly agreed, 2 disagreed, 6 partially agreed and disagreed, and 3 did not directly address the statement. This distribution reflects varied perspectives among pre-service mathematics teachers. While many participants emphasized engagement and enjoyment as important aspects of mathematics learning, others highlighted the complexity of mathematics and the importance of maintaining conceptual challenges.

Student Motivation and Engagement

This theme accounted for 23 coded segments and included two categories: Positive attitudes toward learning (n=13) and Participation and engagement (n=10). Responses within this theme reflected participants’ emphasis on students’ affective experiences with mathematics, particularly the role of enjoyment, motivation, and active involvement in learning. Within the Positive attitudes toward learning category, participants described mathematics instruction to foster students’ confidence, interest, and positive dispositions toward the subject. One participant explained that “teaching mathematics should be easy and fun because it will help students develop a positive attitude towards the subject, which in turn will lead to better learning outcomes overall.” The Participation and engagement category highlighted participants’ views that engaging instruction can encourage students’ involvement and interest in mathematics. One participant noted that “making math easy and fun will also increase student engagement and motivation,” emphasizing that student engagement was connected to deeper understanding and retention of mathematical ideas.

Cognitive Development

The cognitive development theme included 23 coded segments and included three categories: Critical and creative thinking (n=6), Problem-solving (n=6), and Conceptual understanding (n=11). Responses within this theme reflected participants’ emphasis on mathematics as a subject that involves reasoning, exploration, and the development of deeper understanding. Within the Critical and creative thinking category, participants described mathematics learning as involving opportunities for students to think creatively, reason logically, and engage with challenging ideas. One participant explained that incorporating "relevant real-world situations will draw students in and support their problem-solving skills while also allowing them to express their creativity." The Problem-solving category highlighted participants' emphasis on encouraging students to analyze problems, explore different approaches, and develop higher-order thinking. One participant noted that mathematics instruction should not always be easy because "it is important to encourage critical thinking among students by asking thought-provoking questions that inspire students to determine the 'Why?'"

The Conceptual understanding category reflected participants' focus on helping students develop meaningful understanding of mathematical ideas. Participants emphasized the importance of moving beyond surface-level procedures and creating opportunities for students to engage with concepts. For example, one participant explained that when students are "forced to take mindless notes while listening to a teacher lecture on a new mathematical concept," they may be less likely to "internalize the information being taught" because they are not given opportunities to explore and communicate mathematical ideas.

Teacher and Teaching

This was the most prominent theme, with 45 coded segments and included five categories: Instructional methods and strategies (n=20), Teaching resources and representations (n=12), Teacher as facilitator (n=8), and Student-centered approaches (n=5). Participants described a range of instructional practices aimed at making mathematics more accessible and engaging, including collaborative activities, differentiated approaches, representations, and interactive instruction. Participants emphasized the role of teachers in guiding and supporting students' learning. One participant stated, "a teacher is responsible for many things, but the most important is to guide students in the right direction." Another participant highlighted the importance of engaging and student-centered instruction, explaining that "the only way students will truly enjoy learning math is by making it fun for them, engaging, and student-centered." Participants also described specific instructional activities, including games and teamwork, as approaches for promoting student participation in mathematics learning.

Context and Real-world Relevance

The theme accounted for 18 coded segments and included two categories: Real-life applications (n=13) and Learning diversity (n=5). Participants emphasized the importance of connecting mathematics to students' experiences and recognizing differences among learners. Within the Real-life applications category, participants described real-world connections to make mathematics more meaningful and relevant to students. One participant explained that educators should "make connections between the content and student lives" while providing opportunities for exploration, creativity, and collaboration. The Learning diversity category reflected participants' recognition that students have different ways of learning and understanding mathematics. One participant noted that "teaching mathematics is not easy because every student is different depending on the way they learn and grasp the content."

Barriers and Challenges in Learning

The theme of barriers and challenges in learning included 11 coded segments and included two categories: Student difficulties and attitudes (n=7) and Traditional instructional practices (n=4). Participants described challenges associated with balancing accessibility, engagement, and mathematical rigor. One participant noted that "teachers must strike a balance between making the content accessible and enjoyable while still challenging students to expand their talents and achieve their full potential." Participants also referenced traditional instructional practices as potential barriers to engagement. One participant explained that "students get more out of a lesson or activity when they are engaged. If they are only sitting there and taking notes, and just doing what the teacher is doing, then they won't really learn."

Positional framing: Making Mathematics Easy and Fun

In response to Prompt 3, "How would you make mathematics easy and fun to learn and understand? Be specific, please," participants' responses generated a total of 152 coded segments, organized into five themes: Instructional strategies (n=37), Real-life relevance (n=19), Manipulatives and visuals (n=44), Technology integration and gamification (n=44), and Collaboration and social learning (n=8). From a positional framing perspective, participants described a range of instructional approaches through which they envisioned supporting students' mathematical learning. Across responses, they emphasized the use of differentiated instruction, meaningful contexts, concrete representations, interactive resources, and collaborative learning to make mathematics more accessible and engaging.

Instructional Strategies

The theme of instructional strategies accounted for 37 coded segments and included four categories: Breaking down concepts (n=7), Learning style (n=8), High-level thinking (n=7), and Student-centered practices (n=15). Participants described instructional approaches focused on making mathematics accessible, supporting diverse learners, and promoting active engagement. Participants emphasized the importance of scaffolding and breaking down complex mathematical ideas to support understanding. One participant explained that "the easiest way to make math fun and easy to understand is by breaking content down and scaffolding so that new knowledge builds upon old knowledge." Participants also highlighted the need to adapt instruction to students' different ways of learning, noting that "there are many strategies that students can have fun with math and it could also help the students with different learning styles." In addition, participants emphasized creating supportive classroom environments where students feel comfortable participating and making mistakes. One participant stated, "I would want them to feel like it's okay to get a wrong answer or even say an incorrect answer out loud" highlighting the importance of confidence and emotional safety in mathematics learning. Participants also referenced the use of higher-order thinking questions and differentiated instruction as ways to extend students' mathematical thinking.

Real-life Relevance

This theme included 19 coded segments and included two categories: Real-life (n=15) and Cultural connections (n=4). Participants emphasized the importance of connecting mathematics to students' everyday experiences and meaningful contexts. Participants described real-world applications to make mathematical ideas more relevant and engaging for students. One participant suggested moving beyond procedural explanations by stating, "Instead of showing students videos strictly on how to solve a problem for a certain topic, show students videos that explain real world applications of the topic." Another participant emphasized the importance of connecting mathematics to students' identities and experiences, noting that "something else is aiming to relate it to their personal lives and making it 'culturally relevant' too." Participants also highlighted that students may be more motivated to engage with mathematics when they recognize its practical value.

Manipulatives and Visuals

The Manipulatives and visuals theme accounted for 44 coded segments and included three categories: Visual learning (n=7), Hands-on learning (n=14), and Math manipulatives (n=23). Participants emphasized the use of concrete materials, visual representations, and interactive experiences as approaches for supporting students' understanding of mathematics. Participants described manipulatives and visual resources as ways to make mathematical ideas more accessible and engaging. One participant explained that they would support learning "by utilizing different techniques and materials such as concrete manipulatives, online/virtual manipulatives, different representations, games, group activities, videos, etc." Another participant highlighted the value of combining multiple approaches, stating that "it allows students to experience math in a tactile, visual way." Participants also emphasized the importance of active engagement through hands-on experiences, noting the value of providing lessons that are "engaging, challenging, and hands-on."

Technology Integration and Gamification

The theme of technology integration and gamification comprised 44 coded segments and included four categories: Types of math games (n=27), Gamification techniques (n=9), and Technology (n=8). Participants described games, digital tools, and interactive activities as approaches for making mathematics more engaging and supporting student participation. Participants referenced a variety of games and activities, including both physical and digital formats. One participant explained, "I would incorporate games; physical such as Sudoku, math bingo, and math Jeopardy, or virtual such as 'math playground'… These games could also be used as additional study resources or informal assessments." Another participant highlighted the integration of multiple resources, including "manipulatives, hands-on activities, videos, game boards, music, escape rooms, stations, [and] iStation math," to support different ways of engaging with mathematics. Participants also emphasized the role of technology-based tools, noting that "hands-on activities, group projects, and technology-based tools" can make learning "more dynamic and engaging."

Collaboration and Social Learning

This theme included 8 coded segments and highlighted participants' emphasis on collaborative work as part of mathematics instruction. Participants described collaboration as an opportunity for students to communicate ideas, explore different approaches, and engage with mathematical concepts. One participant emphasized the importance of providing opportunities for students "to collaborate with one another to communicate their ideas and learn alternate methods of problem-solving." Another participant described collaborative learning activities as part of a broader approach to making mathematics engaging, including "making connections between the content and student interests" and providing opportunities for students to explore concepts through hands-on learning.

Positional Framing: Teaching Division of Fractions

In response to Prompt 4, "Division of fractions is considered a difficult topic in the middle school curriculum. How would you make this topic easy and fun to learn and understand? Provide details, please", participants' responses generated a total of 72 coded segments, organized into three themes: Instructional strategies (n=24), Representations (n=21), and Games and interactive activities (n=27). From a positional framing perspective, these responses illustrate how teacher candidates described their role in supporting students' understanding and engagement when teaching fraction division. Overall, participants proposed a combination of conceptual scaffolding, concrete representations, and interactive activities to make the topic more accessible and engaging.

Instructional Strategies

This theme was the most prominent, with 24 coded segments, and included five categories: Step-by-step instruction (n=5), Problem-solving (n=5), Hands-on activities (n = 3), Teaching techniques (n = 4), and Real-world connections (n=7). Participants described a range of instructional approaches for supporting students' understanding of fraction division. Participants emphasized breaking mathematical ideas into manageable steps and providing opportunities for hands-on learning. One participant explained that "fractions can be learned easily through modeling" and noted that some students benefit from "hands-on activities such as manipulatives." Another participant described using "visual aids such as flow charts and diagrams" and breaking the process into "smaller, more manageable sections" to support students' understanding of fraction division. Participants also emphasized connecting the concept to meaningful contexts, suggesting discussions about "the various ways division of fractions is used in our daily lives."

Representations

The Representations theme included 21 coded segments and comprised three categories: Manipulatives (n=13), Physical objects and materials (n=5), and Visual aids (n=3). Participants emphasized the use of concrete and visual support to help students develop understanding of fraction division. Participants described representations as tools for making abstract mathematical ideas more accessible. One participant highlighted the use of "strip diagrams" to make the learning division of fractions more engaging. Another participant emphasized combining multiple forms of support, including "visual aids, real-world examples, hands-on activities, and breaking down the whole concept of fractions into smaller steps." Participants also described opportunities for students to interact with materials and discuss their thinking, including allowing students to "share their ideas of how they can divide fractions" and learn through exploration with others.

Games and Interactive Activities

This theme accounted for 27 coded segments and included three categories: Games and activities (n=14), Tech-based games (n=4), and Fraction-themed games (n=9). Participants described a variety of game-based activities as approaches for engaging students while teaching fraction division. Participants referenced both digital and classroom-based games, including Quizizz activities, escape rooms, and fraction-themed games. One participant suggested using "a 'Dividing Fractions Quizizz,' a 'Dividing Knockout Game,' a 'Dividing Fractions Maze', and a 'Dividing Pizza Fractions Game'" as activities that could be implemented with classroom materials and manipulatives. Another participant emphasized incorporating "games that are centered around division of fractions" to encourage student participation and "friendly competition." Participants also described activities such as escape rooms, where students solved mathematical tasks to unlock a box and earn a prize.

Relationship Between Epistemological and Positional Framing

The analysis of participants' responses suggests a relationship between how pre-service teachers conceptualized mathematics and how they positioned themselves as future teachers. While participants expressed varied perspectives regarding whether mathematics is difficult, easy, or enjoyable, their responses frequently connected students' experiences of mathematics with instructional approaches and learning opportunities. The cross-case analysis of epistemological and positional framing for each participant is presented in Appendix B.

Participants who described mathematics as influenced by instructional experiences often positioned teachers as facilitators who support students' mathematical understanding. For example, Participant 1 viewed mathematics as not inherently difficult or boring, emphasizing that students' experiences depend on how mathematics is taught and represented. Consistent with this perspective, the participant positioned the teacher as a guide who supports understanding through representations, real-world connections, and scaffolding. Similarly, Participant 19 associated negative perceptions of mathematics with ineffective teaching approaches and described the teacher's role in creating more relevant and engaging learning experiences.

Across responses, participants who emphasized real-world connections and conceptual understanding tended to position students as active participants in the learning process. For instance, Participant 6 described mathematics as becoming more meaningful when connected to students' everyday experiences and positioned the teacher as someone who helps students recognize these connections. Participant 12 similarly emphasized the importance of moving beyond memorization and positioned the teacher as a facilitator who supports students' conceptual understanding. Other participants highlighted the challenging nature of mathematics while still emphasizing the role of instructional support. Participant 18 described mathematical learning as a developmental process that may include challenging stages, positioning the teacher as someone who guides students through this process. Participant 11 similarly acknowledged the complexity of mathematics and emphasized the importance of supporting students as they develop understanding. To increase methodological transparency and illustrate how epistemological and positional framing were articulated across the discussion prompts, Appendix C presents one participant's responses to the four prompts and subsequent discussion board interactions.

Overall, the relationship between epistemological and positional framing indicates that participants generally viewed mathematics as a discipline that can be experienced differently depending on learning conditions, instructional approaches, and opportunities for engagement. Their responses reflect the view of teachers as facilitators of mathematical learning environments and students as participants who develop understanding through interaction, exploration, and support.

Discussion and Conclusion

This study examined pre-service middle school mathematics teachers' responses to four prompts about the nature of mathematics, teaching, and learning through the lenses of epistemological and positional framing. Across the four prompts, participants demonstrated nuanced views that balanced engagement, accessibility, and cognitive rigor. The findings illustrate connections between participants' beliefs about mathematics and the ways they positioned themselves as future teachers when describing approaches to support students' mathematical understanding.

Epistemological Framing: Nature of Mathematics and Its Implications

Prompt 1 revealed participants' epistemological orientations regarding the nature of mathematics and how it is learned. Participants expressed varied perspectives, with some framing mathematics as challenging and requiring reasoning, persistence, and conceptual understanding, while others emphasized clarity, structure, and problem-solving processes. These responses illustrate different ways participants conceptualized mathematical knowledge and learning.

In Prompt 2, participants' reactions to the statement that mathematics should be "easy" and "fun" revealed a tension between valuing student enjoyment and maintaining intellectual challenge. While some participants explicitly agreed that mathematics could be fun, many partially agreed or disagreed, emphasizing that the subject involves complexity and should not be oversimplified. The epistemological framing identified across these responses reflects participants' views of mathematics as both accessible and conceptually demanding. Engagement and motivation were described as important components of learning mathematics, but participants often framed them as complementary to conceptual understanding rather than as substitutes for mathematical rigor.

Positional Framing: Teachers as Facilitators of Mathematics Learning

Prompts 3 and 4 highlighted participants' positional framing by illustrating how they described their roles as future teachers in supporting students' mathematical learning. In Prompt 3, responses focused on approaches for making mathematics engaging and accessible, including instructional strategies, manipulatives, gamification, technology integration, collaborative learning, and visual representations. These responses reflect how participants positioned themselves as facilitators of learning who considered students' cognitive needs, engagement, and diverse ways of accessing mathematical ideas.

In response to Prompt 4, participants emphasized scaffolding, concrete representations, and interactive activities when describing how they would support students' understanding of division of fractions. The integration of instructional strategies, representations, and games suggests that participants' positional framing involves both cognitive and relational dimensions of teaching. Participants positioned themselves as teachers who support conceptual understanding while creating meaningful and accessible learning experiences. These responses illustrate how participants connected instructional approaches with their perceptions of students' needs, experiences, and opportunities for mathematical understanding.

Integrating Epistemological and Positional Framing

Across the prompts, the relationship between epistemological and positional framing became visible through participants' written responses. The integrated participant-level analysis showed how participants' views of mathematics were connected to the ways they described their roles as future teachers. While Prompts 1 and 2 highlighted participants' perspectives on the nature of mathematics, Prompts 3 and 4 illustrated how these perspectives were reflected in the instructional approaches they described for supporting students' learning.

Participants who emphasized conceptual understanding, meaningful connections, and the complexity of mathematics often positioned themselves as facilitators who supported students through scaffolding, representations, collaboration, and contextualized learning experiences. These patterns suggest an alignment between how participants conceptualized mathematics and how they described effective mathematics teaching. Together, these findings highlight how pre-service teachers' understandings of mathematics are connected to the ways they imagine and describe their future instructional roles.

Implications for Teacher Education

These findings suggest several implications for teacher preparation programs. First, cultivating awareness of both epistemological and positional framing can support PSMTs in critically examining how their beliefs about mathematics relate to the ways they describe teaching and learning. Second, emphasizing approaches that integrate conceptual understanding, engagement, and contextual relevance can help teacher candidates navigate the balance between mathematical rigor and accessibility. Finally, providing opportunities for PSMTs to reflect on and develop their roles as facilitators in diverse learning environments may support the development of flexible, student-centered orientations toward mathematics teaching while maintaining attention to mathematical meaning and rigor.

Future Research

Future research could build on these findings by examining how teacher candidates' stated frames translate into actual classroom practice. Observational studies or analysis of lesson plans could provide deeper insights into the extent to which proposed instructional strategies, such as the use of manipulatives, real-life connections, and interactive approaches, are implemented in practice. Additionally, future studies could further explore the dynamic relationship between epistemological and positional framing, particularly how shifts in teachers' beliefs influence their instructional positioning over time and across contexts.

Limitations

The findings of this study provide insight into how teacher candidates conceptualize mathematics, mathematics learning, and teaching in relation to engagement, difficulty, instructional approaches, and classroom experiences. Across the four prompts, participants frequently described effective mathematics teaching as involving a connection between student engagement and mathematical understanding, emphasizing the importance of making mathematics accessible while maintaining attention to conceptual depth. However, these findings are based on participants' self-reported written responses to prompts, which capture their expressed beliefs, perspectives, and descriptions of teaching approaches. These responses do not provide evidence of how participants enact these ideas in classroom settings. Therefore, this study offers insight into how teacher candidates frame mathematics and its teaching within written discourse, while further research is needed to examine how these perspectives may relate to their instructional practices over time.

Significance

This study contributes to mathematics education research by providing insight into how teacher candidates conceptualize the relationship between engagement and cognitive demand in mathematics teaching through epistemological and positional framing. The findings illustrate that participants often described engaging mathematics instruction as involving motivation, conceptual understanding, and attention to mathematical complexity.

These findings have implications for teacher education by highlighting the value of supporting future teachers in examining how their understandings of mathematics relate to the ways they describe their roles as mathematics educators. Providing opportunities for reflection on mathematical knowledge, student learning, and instructional approaches may support teacher candidates in developing more nuanced perspectives on engaging students while maintaining conceptual depth. In doing so, this study contributes to ongoing conversations about how teacher preparation programs can support future teachers in designing meaningful and intellectually rich mathematics learning experiences.

References

Aguirre, J. M., Mayfield-Ingram, K., & Martin, D. B. (2013). *The impact of identity in K–8 mathematics learning and teaching: Rethinking equity-based practices.* National Council of Teachers of Mathematics.

Alvidrez, M., Louie, N., & Tchoshanov, M. (2024). From mistakes, we learn? Mathematics teachers' epistemological and positional framing of mistakes. *Journal of Mathematics Teacher Education, 27*(1), 111–136. https://doi.org/10.1007/s10857-022-09553-4

Boaler, J. (2016). *Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages, and innovative teaching.* Jossey-Bass.

Delahunty, T. & Kimbell, R. (2021). (Re)framing a philosophical and epistemological framework for teaching and learning in STEM: Emerging pedagogies for complexity. *British Educational Research Journal, 47,* 742-769. https://doi.org/10.1002/berj.3706

Domínguez, H. (2011). Using what matters to students in bilingual mathematics problems. *Educational Studies in Mathematics, 76*(3), 305–328. https://doi.org/10.1007/s10649-010-9284-z

Elby, A., & Hammer, D. (2010). Epistemological resources and framing: A cognitive framework for helping teachers interpret and respond to their students' epistemologies. In L. D. Bendixen & F. C. Feucht (Eds.), *Personal epistemology in the classroom: Theory, research, and implications for practice* (pp. 409–434). Cambridge University Press.

Engle, R. A., & Conant, F. R. (2002). Guiding principles for fostering productive disciplinary engagement: Explaining an emergent argument in a community of learners classroom. *Cognition and Instruction, 20*(4), 399–483. https://doi.org/10.1207/S1532690XCI2004_1

Goffman, E. (1974). *Frame analysis: An essay on the organization of experience*. Harvard University Press.

Gresalfi, M., & Cobb, P. (2006). Cultivating students' discipline-specific dispositions as a critical goal for pedagogy and equity. *Pedagogies: An International Journal, 1*(1), 49–57. https://doi.org/10.1207/s15544818ped0101_8

Hammer, D., & Elby, A. (2002). On the form of a personal epistemology. In B. K. Hofer & P. R. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 169–190). Lawrence Erlbaum.

Hammer, D., & Elby, A. (2003). Tapping epistemological resources for learning physics. *Journal of the Learning Sciences, 12*(1), 53–90. https://doi.org/10.1207/S15327809JLS1201_3

Hammer, D., Elby, A., Scherr, R. E., & Redish, E. F. (2005). Resources, framing, and transfer. In J. Mestre (Ed.), *Transfer of learning from a modern multidisciplinary perspective* (pp. 89–120). Information Age Publishing.

Harré, R. & van Langenhove, L. (Eds.). (1999). *Positioning theory: Moral contexts of intentional action.* Blackwell.

Herbel-Eisenmann, B., & Otten, S. (2011). Mapping mathematics in classroom discourse. *Journal for Research in Mathematics Education, 42*(5), 451–485. https://doi.org/10.5951/jresematheduc.42.5.0451

Herbel-Eisenmann, B., & Wagner, D. (2007). A framework for uncovering the way a textbook may position the mathematics learner. *For The Learning of Mathematics, 27*(2), 8-14.

Herbel-Eisenmann, B., & Wagner, D. (2010). Appraising lexical bundles in mathematics classroom discourse: Obligation and choice. *Educational Studies in Mathematics, 75*(1), 43–63. https://doi.org/10.1007/s10649-010-9240-y

Hill, H., Ball, D., & Schilling, S. (2008). Unpacking pedagogical content knowledge: Conceptualizing and measuring teachers' topic-specific knowledge of students. *Journal for Research in Mathematics Education, 39(4),* 372-400. https://doi.org/10.5951/jresematheduc.39.4.0372

Hofer, B. K., & Pintrich, P. R. (1997). The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning. *Review of Educational Research, 67*(1), 88–140. https://doi.org/10.3102/00346543067001088

Kaur, N. & Dasgupta, C. (2024). Investigating the interplay of epistemological and positional framing during collaborative uncertainty management. *Journal of the Learning Sciences, 33*(1), 80-124. https://doi.org/10.1080/10508406.2024.2312163

Kurup, P. M., Nethsinghe, R., Li, X., Cherian, J., & Yang, Y. (2023). Building global teaching capacity among pre-service teachers: Epistemological and positional framing in an internationally paired, authentic practicum. *Journal of Studies in International Education*, *27*(2), 336-357.

Patterson, Z. & Ding, L. (2025). Epistemic framing analysis of secondary students during instruction on quantum physics. *Physical Review Physics Education Research, 21.* https://doi.org/10.1103/PhysRevPhysEducRes.21.010116

Russ, R. S. & Luna, M. J. (2013). Inferring teacher epistemological framing from local patterns in teacher noticing. *Journal of Research in Science Teaching, 50*, 284 - 314. https://doi.org/10.1002/tea.21063

Saldaña, J. (2013). *The coding manual for qualitative researchers.* SAGE Publications.

Schoenfeld, A. H. (1992). Learning to think mathematically. In D. A. Grouws (Ed.), *Handbook for research on mathematics teaching and learning* (pp. 334–370). Macmillan.

Sfard, A. (2008). *Thinking as communicating: Human development, the growth of discourses, and mathematizing*. Cambridge University Press.

Shim, S. Y., & Kim, H. B. (2018). Framing negotiation: Dynamics of epistemological and positional framing in small groups during scientific modeling. *Science Education, 102*(1), 128–152. https://doi.org/10.1002/sce.21306

Smith, E. (2024). A teacher's positioning of a multilingual learner in the first month of the academic year. *Research in Mathematics Education, 26*(1). https://doi.org/10.1080/14794802.2022.2133004

Tannen, D. (1993). *Framing in discourse*. Oxford University Press.

Wagner, D., & Herbel-Eisenmann, B. (2009). Re-mythologizing mathematics through attention to classroom positioning. *Educational Studies in Mathematics, 72*(1), 1–15. https://doi.org/10.1007/s10649-008-9178-5

Wendell, K. B., Swenson, J. E. S. & Dalvi, T. S. (2019). Epistemological framing and novice elementary teachers' approaches to learning and teaching engineering design. *Journal of Research in Science Teaching, 56*(7), 956-982. https://doi.org/10.1002/tea.21541

Yackel, E., & Cobb, P. (1996). Sociomathematical norms, argumentation, and autonomy in mathematics. *Journal for Research in Mathematics Education*, 27(4), 458–477. https://doi.org/10.5951/jresematheduc.27.4.0458

Appendix

Appendix A.

Sample of the Coding Procedure: Enzo's Reaction to Prompt 1 – Somewhat Agree

Enzo's Reaction	Codes	Categories	Themes
"Mathematics has always been that one subject that students either love or hate. Personally, I *somewhat agree* with this statement. I have never viewed math as a boring subject, but I did find it difficult and struggled a bit with it throughout my academic career. Mathematics has never come easy to me. There were times when I wanted to give up and say "well I guess I'm just not good at math." However, I didn't allow myself to surrender to that mindset. I put the work in; I constantly studied, attended tutoring, figured out different ways to understand a concept, and utilized a multitude of strategies for support. So based on my own personal experience with mathematics, I can understand why some people consider it a difficult and boring subject. There are also several factors that I believe could lead them to view math this way. One factor could be the chosen teaching method. Every teacher teaches math differently. Some students might respond better to a different type of instruction than what that specific teacher is implementing. For example, one teacher may focus too much on the memorization of formulas and equations, rather than on helping students understand the underlying concepts. They may also utilize one style of teaching, rather than differentiating instruction and incorporating a variety of learning approaches. Two other major factors could be the fear of failure or negative past experiences. Math can be a challenging subject, and many students may feel intimidated by the prospect of getting a problem wrong or failing a test, especially if that student typically excels in other	• Either love or hate • Never viewed math as boring • Find it difficult and struggled a bit with it • Mathematics has never come easy • Wanted to give up • I'm just not good at math • I didn't allow myself to surrender • I put the work in • I constantly studied • Different ways to understand a concept • Multitude of strategies for support • Some people consider it a difficult and boring subject • One factor … teaching method • Every teacher teaches math differently • Students respond… to different type of instruction • Memorization of formulas and equations • Helping students understand the underlying concepts • Style of teaching • Differentiating instruction • Variety of learning approaches • Fear of failure • Negative past experiences • Math … a challenging subject	• Attitude toward mathematics (e.g., love math, hate math) • Experience with mathematics (e.g., wanted to give up, not good at math, not allowing to surrender, fear of failure, negative past experiences)	Student experience
		• Teaching mathematics (e.g., multitude of strategies for support, teaching method, different types of instruction, style of teaching, differentiated instruction) • Teacher characteristics (e.g., every teacher teaches math differently, helping students understand, teacher influence)	Teacher and teaching
		• Learning mathematics (e.g., mathematics has never come easy, I constantly studied, different ways to understand a concept, variety of learning approaches)	Learning process
		• Mathematics and its nature (e.g., math is not boring… yet difficult, math is	Content characteristics

subjects. Some students may also have had negative experiences with math in the past, such as repeatedly receiving low or failing grades or simply being told they are “bad at math.” Teachers have a major influence on students' perceptions and attitudes. If we make math exciting and meaningful by providing opportunities for real-world connections, exploration, creativity, and varied instruction, we might be able to change a student's opinion of math being boring and difficult.”	• Students may feel intimidated • Getting a problem wrong • Failing a test • Repeatedly receiving low or failing grades • Being told you are “bad at math” • Teachers influence • Making math exciting and meaningful • Real-world connections • Exploration • Creativity • Varied instruction • Changing student's opinion	challenging, struggled with math) • Content-related issues (e.g., memorization of formulas and equations, making math exciting and meaningful, real-world connections, explorations)	

Appendix B.

Teachers' Frames Across the Prompts

Participant	Epistemological frame (Prompts #1, #2)	Positional frame (Prompts #3, #4)	Relationship between frames
Participant 1	Mathematics is not inherently difficult or boring; students' experiences with mathematics depend on how it is taught and represented.	Positions the teacher as a guide who supports students' mathematical understanding through representations, real-world connections, and step-by-step scaffolding. Positions students as learners who develop understanding through supported exploration.	The participant's view of mathematics as shaped by instructional experiences is reflected in positioning the teacher as someone who can influence students' understanding through representations, real-world connections, and scaffolding.
Participant 2	Mathematics can be challenging but meaningful when connected to real-world situations. Teachers play an important role in helping students see relationships between mathematical concepts and everyday contexts.	Positions the teacher as a facilitator who creates meaningful learning experiences through hands-on instruction, critical thinking, and collaboration. Positions students as participants who construct understanding through exploration and communication.	The participant's emphasis on real-world connections as a way to make mathematics meaningful is reflected in positioning the teacher as someone who helps students recognize relationships between mathematical concepts and everyday contexts.
Participant 3	Mathematics is not inherently boring or difficult; it can become enjoyable when taught by a knowledgeable and passionate teacher who creates engaging experiences.	Positions the teacher as an agent who can influence students' mathematical experiences and create engaging learning environments.	Positions the teacher as an agent who can influence students' mathematical experiences and create engaging learning environments.
Participant 4	Mathematics is connected to everyday life, while traditional approaches may limit creativity and opportunities to make connections.	Positions the teacher as a facilitator who supports students' mathematical sense-making through exploration, collaboration, differentiation, and guided instruction. Positions students as contributors who communicate ideas and develop problem-solving strategies.	The participant's view of mathematics as connected to meaningful contexts aligns with positioning the teacher as someone who helps students construct understanding through connections and exploration.
Participant 5	Mathematics can be difficult, but it does not have to be boring; connections to real-world situations can make mathematics engaging and meaningful.	Positions the teacher as a creator of a supportive learning environment who builds students' confidence through encouragement, collaboration, and engaging activities. Positions students as participants who communicate ideas and take risks in learning.	The participant's view that mathematics becomes more meaningful through engagement and connections to students' experiences is reflected in positioning the teacher as someone who supports students' confidence and creates opportunities for participation.

Participant 6	Mathematics can appear boring when it is disconnected from students' everyday lives; meaningful connections can make mathematics more understandable.	Positions the teacher as a facilitator who helps students connect mathematics to their everyday experiences. Positions students as learners who construct understanding through contextualized experiences.	The participant's view that mathematics becomes meaningful when connected to real-life contexts is reflected in positioning the teacher as a facilitator who helps students recognize and explore those connections.
Participant 7	Mathematics can become interesting and understandable when students recognize its connections to everyday life rather than experiencing traditional, disengaging instruction.	Positions the teacher as a designer of engaging learning experiences through music, games, technology, and representations. Positions students as active learners who participate through interactive experiences.	The participant's view that mathematics becomes accessible through engaging experiences aligns with positioning the teacher as someone who can influence students' relationships with mathematics through instructional design.
Participant 8	Mathematics exists across everyday experiences and can be connected to multiple contexts, although it may not appeal equally to all learners.	Positions the teacher as someone who makes mathematics meaningful by connecting concepts to everyday experiences and recognizing different ways of approaching mathematical problems.	The participant's view of mathematics as present in everyday life is reflected in positioning the teacher as someone who helps students recognize and access mathematics in different ways.
Participant 9	Mathematics can become interesting when students are able to recognize connections among concepts and experience effective instruction.	Positions the teacher as a facilitator who creates accessible mathematical experiences through varied materials, exploration, and connections to real-world contexts.	The participant's belief that mathematical understanding develops through meaningful connections is reflected in positioning the teacher as a facilitator who supports students' exploration and engagement with mathematics.
Participant 10 (Enzo)	Mathematics can be perceived as difficult depending on instructional methods and students' experiences; ineffective teaching can contribute to negative attitudes and fear of failure.	Positions the teacher as a supportive facilitator who creates inclusive learning opportunities through varied instruction, meaningful connections, and positive classroom interactions. Positions students as learners who develop understanding through participation and discussion.	The participant's view that instructional experiences shape students' perceptions of mathematics aligns with positioning the teacher as an influential agent who creates environments that support students' confidence and engagement.
Participant 11	Mathematics is a challenging subject that requires effort, particularly when students encounter complex multi-step processes.	Positions the teacher as a facilitator who supports students' development of understanding and progress through mathematical learning.	The participant's view of mathematics as challenging is reflected in positioning the teacher as someone who supports students in overcoming difficulty and developing understanding.
Participant 12 (Erica)	Mathematics can become difficult when students focus on memorizing procedures rather than understanding mathematical meaning.	Positions the teacher as a responsive facilitator who supports students' understanding and helps them move beyond memorization.	The participant's view that mathematics becomes difficult when reduced to memorization is reflected in positioning the teacher as someone who supports students' conceptual understanding.

Participant 13	Students may develop negative views of mathematics when they do not understand mathematical concepts.	Positions the teacher as a facilitator who creates accessible learning experiences through representations, support, and opportunities for students to develop understanding.	The participant's emphasis on the importance of understanding mathematical concepts is reflected in positioning the teacher as a facilitator who provides support and representations to help students make sense of mathematics.
Participant 14	Mathematical understanding is influenced by instructional experiences, individual differences, and opportunities to develop critical thinking.	Positions the teacher as a facilitator who creates engaging learning environments who creates engaging learning environments through varied resources, collaboration, and opportunities for participation. Positions students as learners whose engagement is supported through meaningful experiences.	The participant's view that mathematical learning depends on multiple factors aligns with positioning the teacher as someone who creates varied opportunities for students to engage with mathematics.
Participant 15	Mathematics can become difficult when students focus on memorizing procedures rather than developing understanding, particularly in middle school.	Positions the teacher as a relational facilitator who creates a supportive classroom environment, values students' voices, and promotes participation through collaboration.	The participant's emphasis on understanding rather than memorization aligns with positioning the teacher as someone who creates classroom conditions that support students' engagement and mathematical learning.
Participant 16	Students' perspectives of mathematics are influenced by personal backgrounds, previous experiences, learning styles, and the ways mathematics is taught and presented.	Positions the teacher as a facilitator who creates meaningful and supportive learning experiences through contextual connections, scaffolding, and feedback.	The participant's view that students' experiences shape their relationship with mathematics is reflected in positioning the teacher as responsive to students' needs and experiences.
Participant 17	Mathematics can be interesting and useful for solving everyday problems, but it can also become frustrating when students encounter numerous rules and procedures.	Positions the teacher as an inclusive and empathetic facilitator who creates a supportive environment, values students' experiences, and encourages collaboration. Positions of students as contributors whose ideas and problem-solving processes are valued.	The participant's view of mathematics as both useful and potentially frustrating aligns with positioning the teacher as someone who supports students through challenges while maintaining meaningful engagement.
Participant 18	Mathematics includes developmental stages that may initially feel repetitive or challenging but contribute to becoming a stronger mathematical thinker.	Positions the teacher as a responsive facilitator who recognizes students' learning processes and provides support as students develop mathematical abilities. Positions students as learners who progress through effort and practice.	The participant's view of mathematics as a process that requires development and effort is reflected in positioning the teacher as someone who guides students through stages of learning.
Participant 19	Mathematics is often perceived as boring because of ineffective teaching approaches, but it can become interesting and engaging when teachers make it relevant and meaningful.	Positions the teacher as a facilitator who structures accessible and meaningful learning experiences through scaffolding, contextual connections, and interactive activities. Positions students as learners who develop understanding through supported practice and exploration.	The participant's view that students' experiences with mathematics are influenced by how mathematics is taught is reflected in their positioning of the teacher as someone who can make mathematics more relevant, accessible, and engaging through instructional approaches.

Appendix C.

Enzo's Excerpts of Reactions to Prompts (P) and Discussion Board Posting (DB)

P1	Personally, I somewhat agree with this statement. I have *never* [emphasis added – MT] viewed math as a boring subject, but I did find it difficult and struggled a bit with it throughout my academic career. Mathematics has never come easy to me. There were times when I wanted to give up and say "well I guess I'm just not good at math." However, I didn't allow myself to surrender to that mindset. I put the work in; I constantly studied, attended tutoring, figured out different ways to understand a concept, and utilized a multitude of strategies for support.
P2	Teaching mathematics should be easy and fun because it will help students develop a positive attitude towards the subject, which in turn will lead to better learning outcomes overall. Mathematics itself is an essential subject that is used in everyday life, so it is extremely important for students to develop proficiency in it. Teachers need to aid students in seeing its relevance and understanding the practical applications.
P3	I would make mathematics easy and fun to learn and understand by incorporating various strategies such as using games, technology, real-world examples, hands-on activities, collaborative learning, and creating a positive, safe, and welcoming classroom environment.
P4	I would make fractions easy and fun to learn and understand by implementing a variety of different strategies. I would include the use of visual aids (e.g., fraction bars and circles), real-world examples (e.g., recipes and measuring cups), hands-on activities (e.g., Play-Doh pizza making or cookie baking), and breaking down the whole concept of fractions into smaller steps.
DB	Hi Erica[1], I really enjoyed reading your discussion post! Personally, I was one of those students that found math a bit difficult and boring at times. A big factor that played a role in that mindset was definitely how I was taught. Memorization was always at the forefront throughout my entire mathematics education. My teachers focused on being able to know the correct procedures and steps over all else. They never really explained the true meaning behind the concepts or the real-world relevance. … As future teachers, we have to learn from our past academic experiences and do better for our own students. In your discussion post, you state, "teach students in a way that is interesting and there is a reason behind what they are doing..." I completely agree with your viewpoint. It is up to us to come up with meaningful and strategic mathematic instruction, as well as provide countless opportunities for our students to work with the material.
Integration of frames	Enzo's reaction to Prompt 1 indicates the nature of his epistemological frame "math is difficult" and emphasizes his "struggle with mathematics," which later was echoed by his reaction to Erica's posting: "I was one of those students that found math a bit difficult and boring *at times* [emphasis added - MT]" with memorization being "at the forefront" in his "entire mathematics education." This epistemological frame explains his desire to "learn from our past academic experiences" and make mathematics "meaningful and strategic" to learn and understand (positional frame).

[1] We used a pseudonym. Also, we indicated the slight change in Enzo's positioning with emphasis added.

Declarations:

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Data Availability Statement: The datasets analyzed during the current study are not publicly available because they contain information that could compromise participant privacy and consent. Data may be available from the corresponding author upon reasonable request and subject to Institutional Review Board (IRB) approval requirements.

Use of Artificial Intelligence Statement: In the spirit of transparency, we acknowledge that as non-native English speakers, we utilized Grammarly to enhance language quality and eliminate grammatical errors, followed by thorough review and verification. This assistance was limited to language enhancement and did not involve content generation or analysis. All research design, data collection, analysis, and interpretation remain entirely the work of the researchers.

Ethics Statement: This study was approved by the Instructional Review Board at The University of Texas at El Paso under protocol no 1763924-4.

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