RELATIONSHIPS FIRST HIGH DOSAGE MATHEMATICS TUTORING: WHAT CAN WE LEARN FROM A LITERATURE SYNTHESIS?

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This paper shares a synthesis of the literature related to the application of a relationships-first approach to high-dosage math tutoring. In the context of our research, high-dosage tutoring is delivered multiple times per week during the school day by paraprofessionals who work with students in historically under-resourced schools. We apply a critical perspective to frame the importance of attending to interpersonal relationships during tutoring. We then explain the core ideas of small group interactions, dialogue, relational interactions, care and belonging and provide a synthesis of these constructs. The literature synthesis presented is intended to be applied to research-based efforts aimed at supporting tutors working to increase their skills for cultivating strong interpersonal relationships and enacting equity oriented pedagogy.

Keywords: Equity, Inclusion, and Diversity, Communication, Classroom Discourse, Affect, Emotion, Beliefs, and Attitudes

The opportunity for students to develop positive personal relationships as part of their content-based interactions during math tutoring is often presented as the keystone of a human tutoring model, providing support that cannot be offloaded onto current or forthcoming technologies, even ones using modern Artificial Intelligence. This is especially true in high dosage tutoring contexts where the same tutor works with a designated group of students throughout an academic year. Research demonstrating that strong teacher-student bonds can enhance student motivation and engagement, and positively impact learning outcomes (Davis, 2003; O'Connor & McCartney, 2007) underscores the value of a relationships-first human tutoring model.

One component of the University of Colorado Boulder (CU) and Saga Education research project is focused on contributing to the professional growth of novice tutors learning to cultivate strong personal relationships with their students. Specifically, the CU and Saga research team is studying discourse-based interactions in the tutoring context and incorporating this knowledge into artificial intelligence (AI) models to generate feedback to help tutors and the coaches who work with them improve their effectiveness. Leaning into the keystone benefit of human tutoring, the primary focus for tutors' professional growth centers on improving tutors' use of discourse and dialogue about mathematical concepts and supporting tutors' ability to cultivate increasingly caring and supportive relationships with their students. One goal of this research is to support tutors to learn how to weave interpersonal relationship building throughout the time they spend

working with students on mathematical content for the dual purpose of increasing students' math learning and supporting students' general well-being.

Context and Overview

Historically, tutoring has been primarily available to those who hire private tutors to support enhanced academic success for students whose families can afford to pay for this service (Nelson-Royes, 2015). Providing tutoring to a more economically diverse population of students has been shown to be a valuable strategy for reducing achievement and opportunity inequities and supporting students' emotional well-being (Carlana & La Ferrara, 2021). In recent years tutoring, and particularly high-dosage tutoring provided in school during the school day, has been promoted as a way to support students and help address achievement inequities – this effort has increased in the aftermath of school closures and online learning during the Covid-19 pandemic (Carlana & La Ferrara, 2021). This increased attention and momentum has led to a rapid increase in the availability of tutoring during the school day for students who are less likely to be able to afford the cost associated with hiring a private tutor. As of 2015, 32% of US high schools required academic tutoring for at least some of their students (US Department of Education, 2017). More recently the U.S. Education Secretary, Miguel Cardona, has advocated for all students who are academically behind grade-level to receive high-dosage tutoring (at least 90 minutes per week), and COVID relief funds have provided a source of funding to support tutoring services in schools (Stavely, 2022).

The increase in human tutors working with students during the school day has several unique affordances. First, opportunities for students to work in small groups, for an extended period, with a knowledgeable math adult, tend to be rare in traditional classrooms. In an example of a context in which some students may receive small group instruction and where students have opportunities to engage with highly trained adults providing personalized support - students who receive special education services - the supporting teachers may not have the math knowledge necessary to effectively bring about high levels of learning, and not all students receive this support. Tutors who deliver high dosage tutoring can provide unique benefits by bringing high levels of math content knowledge to a small group tutoring context that is provided to all.

Second, tutors provide socio-cultural and relational support that is not always possible in classrooms. The population of people hired as tutors is more diverse than the teaching workforce (Contreras, 2022) and more demographically aligned with the population of students they are working with. The population of tutors whose professional growth our research supports includes 54% people from nondominant backgrounds, 19% of whom identify as Latine. These demographic characteristics increase the likelihood of students working with tutors with whom they share identity group memberships and/or cultural backgrounds, affinity and experiences. The combined scenario of working for extended periods of time in small groups paired with the potential for common experiences associated with shared identity group memberships and cultural backgrounds creates a powerful and unique opportunity for tutors to support students both academically and personally in ways that complement and augment other supports that exist in traditional school settings.

Theoretical Perspective

Our work is grounded in the perspective that incorporating interpersonal relationship building throughout tutoring sessions in ways that are integrated with content instruction contributes to supporting students' well-being and plays a central role in students' increased understanding and knowledge about math. Foregrounding interpersonal relationships supports students' thriving as both math learners and as developing young adults.

A critical perspective casts a powerful lens to understanding these theoretical commitments and thus better supporting this development. A critical perspective focuses attention on how math instruction that supports the "mathematical identities, excellence and literacies of marginalized students" (Gutiérrez, 2008, p. 357) may differ from instruction that leads to increased test scores and reduced participation gaps. Despite a longstanding call in math education research literature for math teaching to incorporate a critical perspective (e.g., Gutiérrez, 2007; Martin, 2003), math tutoring continues to be almost exclusively oriented toward increasing students' knowledge of math content with insufficient attention paid to how tutors and students relate to each other as more complete human beings. Gutiérrez's (2009) provides an initial framework for understanding equity in math that explains the importance of relationship building in high-dosage human tutoring contexts.

Gutiérrez's (2009) framework consists of two axes: the dominant axis includes the dimensions of access and achievement, and the critical axis includes the dimensions of identity and power. Tutoring models align with the dominant axis via their aim to increase students' content knowledge. By providing students with access to learning opportunities tutoring may increase students' achievement of academic success in math which may be indicated on assessments showing absolute increases in learning outcomes or reduced differences in achievement between identity groups. Tutoring models that only attend to mathematical content, without attending to interpersonal relationships, fail to account for the critical axis, including the impact of students' experiences with identity and power dynamics on their learning.

In delineating what is required in equitable math, Gutiérrez calls attention to the need to engage with students' unique identities and the power dynamics at play in math learning spaces. Engaging in math teaching and learning in ways that reflect distributed power structures can support more student-centered learning, students' agency and students' mathematical identities and sense of belonging. Students have been shown to benefit from opportunities to bring their lived experiences to bear on the task of learning math in ways that align with their personal identity group memberships and individual perspectives and experiences (Esmonde, 2009; Battey et al. 2016; 2018; Ford et al. 2014).

Dialogic learning spaces are an example of attention to both the dominant and critical axes. These spaces are built around rich and generative interactions between instructors and students that enable people to get to know each other's unique ways of thinking and doing math. The goal is supporting students to develop conceptual understandings of math that are rooted in their individual perspectives and lived experiences.

Literature Related to Relationship-First Instruction

A commitment to building strong interpersonal relationships in the context of high-dosage math tutoring has been justified using a broad range of evidence from research literature. Gutiérrez's framework provides a scaffold to situate additional components that are especially

relevant to the classroom in general and tutoring specifically. Looking at the dominant axis, the incorporation of tutoring into a student's daily practice increases access and provides more support to increase achievement. Since tutoring inherently takes place in small groups it can bring about specific benefits unique to small group instructional contexts including increased opportunities for dialogue. Examining the critical axis, we draw from literature on relational interactions, care and belonging as relevant components necessary for attending to students' experiences of identity and power dynamics, and we observe that each of these elements is interrelated and critical to student success and wellbeing.

Small groups: creating a context for learning and growth

Tutoring constitutes a unique context in which students are working in small groups, but they have the full-time participation of an adult who holds extensive math content knowledge. Research on small group mathematical activity, and equity and inclusion in small groups working on mathematical tasks, may apply to the tutoring context, recognizing that the tutor's full-time participation differs from the role a teacher plays in a classroom setting. The presence of a tutor could potentially undermine the opportunity that is normally available to students working in small groups to exercise agency over how they engage with mathematical content. However, the small group setting offers opportunities for a skilled tutor to facilitate dialogue, engage in relational interactions, convey care, and cultivate a sense of belonging.

Esmonde (2009) proposed a theoretical framework for understanding Opportunities to Learn during small group learning activities. This framework consists of four points about how learning happens: "(a) through participation, (b) in relation to a social ecology, (c) through processes of identity development, and (d) through communicating about mathematical content" (p. 1011). In Esmonde's conceptualization, participation refers to students' opportunities to "move on a trajectory toward more central and competent participation in classroom practices" (p. 1011). Social ecologies in small groups account for the forces that contribute to the social construction of identity within the norms and dynamics of a single small group, along with external influences on identity development such as intersections of race, class, gender, sexuality, language communities and more. Students' identities can be influenced by their experiences engaging in dialogic learning, by their teacher's enactment of relational interactions and expressions of care, and by the degree to which they feel a sense of belonging in the math learning community. Finally, with respect to communicating about mathematical content Esmonde considers the role of shared meaning making in the processes used by small groups working on mathematical activities. Esmonde's (2009) framework provides a way to account for identity and power - Gutiérrez's critical axis - in math learning, paying particular attention to the experiences of students who are members of nondominant identity groups and considering how students can experience agency in math learning that is relevant within their unique life experiences.

Dialogue: connecting student and tutors together

The term 'dialogue' is often used loosely in reference to discussion or conversation between teacher and students or between multiple students. However, the literature on dialogic teaching and learning has some important characteristics worth attending more closely. Dialogic teaching and learning "characterizes an epistemological relationship," (Freire and Macedo, 2003, p. 191), "a process of learning and knowing" (p. 193) in which all participants have agency in the nature of the learning that occurs and how that learning develops. Billings and Fitzgerald (2002) observed that dialogic discourse can generate a "reciprocal flow of ideas involving actions and

reactions of group members [that] may lead to new understandings not held by any group member in advance of the discussion" (p. 909). The learning that results from collective sensemaking through dialogue moves beyond transactional learning that flows primarily from tutor to students. In other words, dialogic discourse results in learning that is multidirectional which reflects participants unique perspectives, experiences and ways of thinking.

Development of a dialogic learning space is initiated by a teacher or tutor who is skilled at supporting student agency and who cultivates norms of participation that enable movement from peripheral to central roles of participation while considering students' identities and experience of shifting power and authority dynamics. Webb et al. (2019) observe that a teacher's role in creating inclusive and dialogic small group learning environments includes helping students know how to engage in active listening; ask and answer questions; brainstorm suggestions, ideas and opinions; explain and evaluate ideas; use persuasive talk; summarize conversations, and much else (p. 177). Xu and Clarke (2019) describe the importance of teachers considering cultural differences related to students' identities and life experiences that may influence students' participation and interactions with persons in positions of authority and may subsequently impact how students engage in a dialogic learning space. Langer-Osuna and Esmonde (2015) describes complexities of the shifting authority relations present in collaborative and dialogic math learning communities. The role of a teacher or tutor in cultivating a dialogic learning experience extends well beyond the creation of group-worthy tasks to include how these tasks are enacted through the intentional use of dialogic moves.

Relational interactions: attending to how tutors communicate

Literature on relational interactions specifically describes how teachers relate to and interact with their students (Battey, 2013; Battey et al. 2016; 2018). Relational interactions factor into the establishment of care, as will be described below, and they shape students' math learning experiences. Teacher content knowledge and implementation of instructional practices have been shown to be impactful for student learning (Battey, 2013; Battey et al. 2016; 2018), but relationship interactions are equally impactful. A teacher may have extensive content knowledge and be skilled at using an extensive repertoire of instructional strategies, but if they do not establish and maintain supportive relational interactions, students may not thrive. Consideration of the nature of relational interactions is especially relevant for students who identify as members of minoritized groups in society and who are more likely to be learning math from educators whose identity group memberships and cultural backgrounds differ from their own. If teachers' approaches to relational interaction are rooted in different cultural experiences or expectations this may result in relationships with these students that feel less personal or less familiar (Battey et al. 2016; 2018; Ford et al. 2014). Battey et al. (2016) specifically highlight how teachers perceive their African American and Latine students as more confrontational and spend more time disciplining their behavior as compared to their white peers. Ford et al. (2014) addresses the potential differences in how authority is established between White and Black teachers, and how this may impact their relationships with their students. While relational interactions are integrated with the concept of care, they can be more precisely descriptive of how a teacher connects with their students.

Battey et al. (2016; 2018) identified five components of relational interactions that help build such "caring relationships," with a particular lens on instructing minoritized students. These include framing math ability, acknowledging student contributions, attending to culture and

language, addressing behavior, and setting the emotional tone. These dimensions can be tracked by looking at specific forms of dialogic acts or conversational moves. A teacher who takes a positive approach to enacting each of these components can create a supportive learning environment. However, the converse is true as well; if a teacher takes a negative approach, it can diminish the student's willingness to engage and restrict their opportunities to learn. For example, in a case study looking at an elementary math teacher's class, Battey (2013) observed positive framing of ability when the teacher encouraged students on a specific math problem, reminding them of their accomplishments on similar problems. Conversely, negative framing occurred when the teacher was sarcastic and questioned students' basic math skills. Relational interactions highlight how communication can have an immediate impact on students.

Care: establishing authentic relationships

A fundamental component of relationships is the element of care, or attending to the needs of others (Bartell, 2011; Potvin et al, 2022; Maloney & Matthews, 2020). Within an educational context, Noddings (1984, 1988) has applied care theory to describe the teacher-student dynamic. When a teacher shows genuine care and compassion, this can significantly impact the student's educational experience for the better (Bartell, 2011; Maloney & Matthews, 2020).

However, there are many different critical components needed to successfully develop an authentic caring relationship (Bartell, 2011). Caring for a student means attending to their wellbeing at a personal level, and not just caring for their academic success (Maloney & Matthews, 2020). Noddings (1988) describes the need for 'engrossment', meaning the teacher must understand the students' motivations and feelings and provide positive acknowledgment to form a reciprocal relationship. Similarly, Maloney & Matthews (2020) emphasize the need for empathetic care, which is "teacher's authentic expression of identifying with the challenges of their students and prioritizing students' well-being above their own" (p. 408). Maloney and Matthews (2020) found that when students experienced care as transactional or superficial, they were less invested in the class. However, when students felt empathetic care, they felt more connected to the class, that their input was valued, and that math was relevant to them. Whether a teacher shows genuine care for a student as a person, and not just for their academic performance, has ties to greater investment; students want to do better for teachers who care for them (Bartell, 2011; Maloney & Matthews, 2020).

To establish this level of care and understand a student personally, teachers must understand not only the student's identity and background but also their lived experience in the context at large. This is especially important for BIPOC students and any student in a marginalized or systematically oppressed community. To not acknowledge the challenges that have been built into these students' lives is to ignore a major factor in their educational experience (Maloney & Matthews, 2020). This also means teachers should be aware of their own teacher identity and any potential biases they may hold, especially as they are the ones in the position of power within the teacher-student relationship (Bartell, 2011). It is not enough for a teacher to care, the student must also feel cared for to establish an authentic connection (Bartell, 2011). Care in the classroom clearly has many nuances (Bartell, 2011), but is an essential part of maintaining healthy relationships (Potvin et al., 2022).

Belonging: bringing together all members of tutoring groups

Belonging is a multifaceted social construct that typically relates to the perception of inclusion and support within a community and is seen as a basic human need (Allen et al, 2021;

Gray et al. 2018). The sense of exclusion or isolation has been related to poor quality of life and depression (Allen et al., 2021). Thus, establishing a sense of belonging is important for young people, especially in socially interactive academic settings where they spend a significant portion of their time (Barbieri & Miller-Cotto, 2021). Not only is belonging associated with overall wellbeing, but it has also been found that the sense of belonging in a math setting is associated with better academic performance (Gray et al., 2018; Allen et al., 2021; Penuel et al., 2023; Barbieri & Miller-Cotto, 2021). Barbieri and Miller-Cotto (2021) found an association specifically between a sense of belonging in math and subsequent scores. Penuel et al. (2023) found that a student's sense of belonging predicted their level of contributions. This differed by race with White and Asian students contributing more than their Latine peers.

Similar to the findings on care and relational interactions, a sense of belonging is especially impactful for BIPOC students (Barbieri & Miller-Cotto, 2021; Penuel et al., 2023; Gray et al. 2018). Matthews et al. (2021) posits that there are seven key dimensions - 3 interpersonal and 4 instructional - that constitute Belonging Centered Instruction. Educational institutions have historically been a place of exclusion for students who are members of minoritized identity groups, and these experiences can undermine their opportunities to develop a sense of belonging. However, when care is established and positive relational interactions occur, this can bolster a student's sense of belonging. These concepts are interwoven together; when a student feels that a teacher genuinely cares about their wellbeing (often by using positive relational interactions) then the student may feel more belonging and be motivated to contribute and engage (Barbieri & Miller-Cotto, 2021; Penuel et al., 2023; Gray et al. 2018; Maloney & Matthews, 2020).

Relationship Focused Tutoring: Alignment of Constructs with Critical and Dominant Axes

To help us understand the role that each of the previously described constructs can play as components in a relationships-first high dosage tutoring context, we consider the alignment of key aspects of each construct with the dominant and/or critical axis. Notably, each construct contributes to both axes and helps expand Gutiérrez's framework by suggesting how educators can attend to access, achievement, identity, and power. Table 1 shows this alignment.

Table 1: Alignment of Constructs with Dominant and Critical Axes

	Small Groups	Dialogue	Rel. Interact.	Care	Belonging
Dominant	movement toward central participation	student agency	-framing ability -acknowledge contributions	positioning learning content as good for the self	supports academic success
Critical	attention to student's individual needs and experiences	-shifting authority relations -multi-directional learning	-attending to culture and language -set emotional tone	-attend to student wellbeing and lived experiences -empathetic care -potential biases	supports feelings of membership in learning community

Tutoring by nature involves working in small groups. As Esmonde's (2009) framework explains, small group interactions can support students to move toward more central roles of

participation which enhances their access to learning opportunities and potentially academic achievement, the components of the dominant axis. Small group learning contexts also provide opportunities for individualized interactions that attend to students' unique identities and lived experiences, the components of the critical axis.

A dialogic learning space increases students' opportunities to engage with teachers' and tutors' ways of conceptualizing and doing math which has the potential to support access and achievement through students' participation in sense-making about mathematical ideas. The multidirectional nature of the learning generated through dialogic discourse depends on students' opportunities to contribute their own unique conceptualizations and lived experiences in relation to the math they are learning. Learning that results from dialogic interactions is reflective of the ideas, insights and perspectives of all participants and relies on shifting power dynamics and authority structures around who holds and contributes knowledge.

Regarding relational interactions, the ways that educators frame math ability, acknowledge student contributions and address behavior support students' access to learning opportunities, while educators' attention to culture and language and strategies for setting the emotional tone incorporate aspects of the critical axis of equitable math.

Educators' expressions and demonstrations of care attend to the dominant axis' components when they are concerned with how learning mathematical content is good for the students. When educators' enactment of care extends to attending to students' well-being, demonstrating empathy, learning about and being responsive to students' lived experiences, acknowledging and correcting potential biases and engaging in deep and authentic connection the critical axis components of identity and power are being addressed.

Finally, educators' who support the development of students' sense of belonging as it relates to established and accepted practices of doing math are attending to the dominant axis components of access and achievement, while educators' who cultivate learning environments in which students' sense of belonging as unique and valued members of a community of learners are attending to the critical axis components of identity and power.

Conclusion

In the context of high dosage math tutoring in which tutors bring a relationships-first approach to their interpersonal interactions with their students it is helpful to have a clear understanding of what is involved in cultivating strong and productive tutor-student relationships. We propose that a more equitable and inclusive form of math tutoring can be achieved by explicitly considering how tutors engage with students in ways that attend to both the critical (identity and power) and the dominant (access and achievement) axes of equitable math by first building strong positive relationships with students and then leveraging those relationships throughout their interactions about math content. This paper contributes a synthesis of research related to how professionals who work in instructional roles can build relationships that support students' well-being as a mechanism to contribute to increased math learning. This synthesis of the separate but related constructs described in this paper helps to explain how tutors can build positive interpersonal relationships in a high dosage tutoring context, supports the design of professional learning opportunities and contributes to the professional growth of tutors working to improve their skill at supporting and engaging with their students.

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