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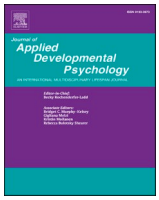

Developmental Relationships as a critical lever for equitable math learning☆

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ABSTRACT

Although Developmental Relationships (DR) have been shown to be critical for a range of academic and social-emotional outcomes, what DR looks like specifically in math learning warrants closer examination. The potential of DR in making math enjoyable and relevant is particularly crucial given the various systemic barriers that disproportionally marginalize certain groups of youth in math. In this paper, we demonstrate DR and its corresponding relational practices as critical levers for equitable math learning using focus group and interview data of 14 staff and 15 students from three programs in the U.S. that upholds a strong commitment to serve Black, Latina/o, and other underrepresented students from low-income backgrounds. Our findings aligned with each of the five pillars of the DR Framework (Express Care, Provide Support, Challenge Growth, Share Power, and Expand Possibilities), and provide initial insights into how the framework may be particularly salient for math learning.

In the U.S., math is a subject with stark inequities in performance (e.g., National Center for Education Statistics, 2022) and participation (e.g., National Center for Science and Engineering Statistics (NCSES), 2023) due to a range of systemic factors such as the pervasive stereotypes around who 'math people' are, inequitable access to high-quality math learning opportunities, lack of representation, colorblind curricula, discrimination, and implicit biases (e.g., Beasley and Fischer, 2012; Collins, 2018; Grossman & Porche, 2014; McGee, 2016; Nasir & Vakil, 2017). For example, racial/ethnic stereotypes and other implicit biases continue to push Black and Latina/o students out from the field at disproportionate rates (Lee, Collins, Harwood, Mendenhall, & Huntt, 2020; McGee, 2013). Relatedly, math is often perceived as an isolated, nerdy, and "cold" subject, which can directly or implicitly marginalize students whose personal aspiration or cultural background place greater value on collectivism, collaboration, and achieving for the greater good (Garriott, Hultgren, & Frazier, 2016; Starr & Leaper, 2019; Ukpokodu, 2011). As yet another example, math as a field often fails to uplift the lived experiences and funds of knowledge of historically resilient, but marginalized groups (Belgrave et al., 2022; González, Andrade, Civil, & Moll, 2001; Nasir & de Royston, 2013; Williams, Tunks, Gonzalez-Carriedo, Faulkenberry, & Middlemiss, 2016). Jointly, these systemic barriers create inequities wherein certain groups of students, such as Black, Latina/o, and students from low-income communities, have disproportionally lower access to high-quality math learning spaces and resources. This inequitable access to high-quality math learning spaces and resources then have substantial implications for individual mobility and broader social injustices in the science, technology, engineering and mathematics (STEM) fields (National Mathematics Advisory Panel, 2008; Watt et al., 2017). Countering such systemic inequities, trusting and developmentally-nurturing relationships have the potential to make math welcoming and enjoyable for *all* students. Thus, the goal and contribution of the current study is to understand the relational approaches that foster trusting, developmentally-nurturing relationships in math learning spaces.

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Importance and affordances of relationships in math learning

In math out-of-school time programs and tutoring, the contexts of interest of this current study, a strong and caring student-staff relationship is consistently and consensually regarded as a key dimension of high quality (Colvin, 2007; Eccles & Gootman, 2002; Kuperminc et al., 2019; Marx, Wolf, & Howard, 2016; Robinson & Loeb, 2021). In a study of a math afterschool program that served Latinx youth from low-income backgrounds for example, positive youth-staff relationships were a main promoter of youth's gain in math interests and social-emotional skills that facilitate math learning (Soto-Lara, Yu, Pantano, & Simpkins, 2021). Relatedly, in a retrospective study of an out-of-school time STEM program, alumni attributed their relationships with staff as the main reasoning behind their increase in STEM career interest (Price, Kares, Segovia, & Loyd, 2019). Simply put, relationship is the conduit of learning, and math learning is no exception; youths learn better and find learning more enjoyable when they can connect with the person delivering the content (Hsieh, 2024; King & Pringle, 2019; Klein & Bell, 2023; Roberts et al., 2018). Focusing on student-staff relationship as a critical lever also has applied implications as relationship building skills are malleable (Bowers, Johnson, Warren, Tirrell, & Lerner, 2015; Klein & Bell, 2023).

Given that the communities we live in are increasingly diverse in terms of racial/ethnic, cultural, socioeconomic, and other backgrounds, culturally responsive relationships are important now more than ever. Culturally responsive teaching, as defined by scholar Geneva Gay (2000), pertains to "using the cultural characteristics, experiences, and perspectives of ethnically diverse students as conduits for teaching them more effectively" (p. 106). Cultural responsiveness centers the principles of respect, improvement-oriented inquiry (i.e., akin to the concept of growth mindset), critical practices that disrupt inequity, and learning about cultural competence and social justice, to name a few. As such, relationship building is arguably a core aspect of culturally responsive math learning because strong and positive relationships between adults and youths provide collaborative learning opportunities across youths' different learning contexts, reinforce their cultural assets, and lift up how math is applicable to their lives (Ukpokodu, 2011; Yu et al., 2021; Yu et al., 2022). In fact, many math learning programs intentionally introduce youth to *near peers* who are similar to them in age, upbringing, and other demographic backgrounds, as such similarities have the potential to make building a connection easier and consequently make math learning more relatable (e.g., Garcia-Melgar & Meyers, 2020; Tenenbaum, Anderson, Jett, & Yourick, 2014; Wilson, Wang, Galarza, Knight, & Patino, 2023). Taken together, the importance of youth-staff relationships cannot be understated, and more studies are needed to better understand how exactly are strong and positive youth-staff relationships fostered in math learning spaces.

Theoretical framework: Positive youth development and Developmental Relationships

With the goal to better understand youth-staff relationships, we used the Developmental Relationships (DR) Framework as a guide for the current study. The DR Framework, rooted within the Positive Youth Development (PYD) literature, is an asset-based framework for understanding adult-youth relationships (Roehlkepartain et al., 2017; Scales, Roehlkepartain, & Houltberg, 2022). The DR Framework articulates the relational actions young people need to thrive. Specifically, Developmental Relationships are defined as close connections through which fundamental processes of growth and development are meaningfully affected. They are close connections through which young people discover who they are, cultivate abilities to shape their own lives, and engage with and contribute to the world around them. Developmental Relationships are more than 'good relationships' because there is not only a sense of mutual/reciprocal bonding and concern, but also the expectation and support for pushing young people to be their best selves (Rhodes, Spencer, Keller, Liang, & Noam, 2006; Scales, Hsieh, & Benson, 2022).

The Developmental Relationships Framework consists of five elements or pillars—Express Care, Provide Support, Challenge Growth, Share Power, and Expand Possibilities—each of which are further expressed and articulated in specific relational approaches (see Table 1). How the five elements manifest through their respective relational approaches may be qualitatively different– for example across subject domain, cultural backgrounds, and situational contexts. As such, the Developmental Relationships Framework lays out the essential tenants of strong relationships while leaving room for local adaptation and contextual nuances, and avoiding a one-size-fits-all prescribed approach.

Each of the elements and actions in the Developmental Relationships Framework is supported by a deep well of research and practice literature across numerous fields and contexts (see Scales, Hsieh, & Benson, 2022; Scales, Roehlkepartain, & Houltberg, 2022; Syversten, Scales, Chavez, & Roehlkepartain, 2022 for reviews). In fact, studies have demonstrated the strong associations between Developmental Relationships and a host of favorable academic and social-emotional outcomes such as GPA, academic motivation, social and communication skills (Domitrovich, Syvertsen, & Calin, 2017; Scales, Pekel, Sethi, Chamberlain, & Van Boekel, 2019; Scales, Van Boekel, Pekel, Syvertsen, & Roehlkepartain, 2020; Search Institute, 2020; Sieving et al., 2017; Sullivan & Larson, 2010). For example, a mixed-method study showed

Table 1
The Developmental Relationships framework.

Developmental Relationships elements	Example relational approaches
Express Care Show me that I matter to you.	Be dependable: Be someone I can trust. Listen: Really pay attention when we are together. Believe in me: Make me feel known and valued. Be warm: Show me you enjoy being with me. Encourage: Praise me for my efforts and achievements.
Challenge Growth Push me to keep getting better.	Expect my best: Expect me to live up to my potential. Stretch: Push me to go further. Hold me accountable: Insist I take responsibility for my actions. Reflect on failures: Help me learn from mistakes and setbacks.
Provide Support Help me complete tasks and achieve goals.	Navigate: Guide me through hard situations and systems. Empower: Build my confidence to take charge of my life. Advocate: Stand up for me when I need it. Set boundaries: Put in place limits that keep me on track.
Share Power Treat me with respect and give me a say.	Respect me: Take me seriously and treat me fairly. Include me: Involve me in decisions that affect me. Collaborate: Work with me to solve problems and reach goals. Let me lead: Create opportunities for me to take action and lead.
Expand Possibilities Connect me with people and places that broaden my world.	Inspire: Inspire me to see possibilities for my future. Broaden horizons: Expose me to new ideas, experiences, and places. Connect: Introduce me to people who can help me grow.

Notes. Relationships are, by definition, bidirectional, with each person giving and receiving. So each person in a strong relationship both engages in and experiences each of these actions. However, for the purpose of clarity, this framework is expressed from the perspective of one young person.

that students' Developmental Relationships with their teacher significantly and positively predicted their academic motivation (Sethi & Scales, 2020). The same study then qualitatively showed that each of the Developmental Relationships element is crucial in explaining this positive association. Specifically, strong Developmental Relationships with teachers in practice included, for example, getting to know students and not take things too seriously unless it was necessary (Express Care), demonstrating clear and high expectations (Challenge Growth), not giving up on student (Provide Support), acting on student suggestions (Share Power), and inspiring students to think about their future (Expand Possibilities). While past studies demonstrated the positive associations between Developmental Relationships and general academic outcome, to date, however, no study has adapted the framework specifically to math learning spaces with one exception. In a recent study, Black and Latina/o students who reported stronger Developmental Relationships with their math teacher also reported being more engaged in math (Hsieh, 2024). For example, students who agreed that their math teacher showed them that they matter (Express Care) were more than three times more likely to report looking forward to math class, compared to students who disagreed that their math teacher showed them that they matter. Taken together, the current study uses the Developmental Relationships Framework (i.e., its five essential elements/pillars) as a foundation for examining what relational approaches emerge specifically in math learning spaces. The following research question guided the study: In what ways did the relational experiences of youths and their mentors/tutors (referred to as "staff" henceforth) in math learning spaces embody each of the five elements of Developmental Relationships (i.e., Express Care, Provide Support, Challenge Growth, Share Power, and Expand Possibilities)? Specifically, with a focus on equity, we centered the experiences of Black and Latina/o youths from low-income backgrounds, as well as the staff who served them.

Method

The study contexts and participants

The data for this study came from three math out-of-school time and tutoring programs. A total of fourteen (14) staff and fifteen (15) youths from the three programs took part in this study (Table 2). Although we did not collect demographic and background information from each individual staff/youth participant, a common focus for all three programs is their commitment to serve Black, Latina/o, and other historically underserved students from low-income backgrounds. The three programs were part of a larger research-to-practice project that took place during the 2021–2022 school year. As part of the larger project, the three programs received monthly professional development workshops on youth-staff relationships, technical assistance on program evaluation, and cross-program supports. Below, we provided program-level description to help contextualize our data and findings.

Table 2
Program contexts.

	Program type	Staff type	Participation this study
Program A	Community-based	Near-peer	Five staff: Staff G, H, R, M, D Five youths: Youth Y, K, B, W, S
Program B	School-based	Adults	Five staff: Staff A, T, P, Q, U Six youths: Youth C, Z, O, R, X, E
Program C	Community-based	Near-peer	Four staff: Staff B, V, F, K Four youths: Youth Q, A, L, P

Program A[2] is a national association with two dozen regional affiliates whose mission is to work with highly motivated, traditionally underrepresented students to achieve post-secondary success and empower aspiring leaders to become the next generation of educators and advocates. Working toward this shared mission, Program A's regional affiliates also have substantial autonomy in terms of their local implementation and programming. At the program level, 74 % of program A's students qualify for free/reduced price lunch, 91 % are first generation college going students, and the majority identify as a student of color (2 % Asian American, 11 % Black, 62 % Hispanic, 3 % Multiracial, 1 % White[3]). Program A's Central Texas affiliate, whose programming had a strong math tutoring focus, took part in this study. Students were eligible to participate in the math tutoring program if they were in the eighth grade, and only if they had participated in previous years of the summer program. Program A's staff were college students, meaning that they were near-peer in relation to the middle school students they serve.

Program B is a Minnesota-based, multi-site math tutoring program whose mission is to help put students on track for college and career success and builds states' futures by preparing students for careers that use STEM concepts. Across Program B, approximately 41 % of students in participating schools qualified for free/reduced price lunch, about 7 % identified as Asian American, 16 % as Black, 13 % as Hispanic, 5 % as Multiracial, 39 % as White, and 1 % as another race, and an additional 20 % declined to state. Two of Program B's sites took part in this study. Program B's staff were community members serving as AmeriCorps members to tutor elementary and middle school students. Staff and students typically participate in Program B for the duration of a school year, that is, for at least nine months.

Program C has a mission to provide year-round, out-of-school-time programs for low-income, at-risk students and their families with the goal of increasing levels of educational attainment in the greater Washington D.C. community. Program C's staff were college or high school students who tutor elementary and middle school students. At the program level, around 60 % of students served by the Program C identify as Hispanic/Latino, 30 % as African/African American, 9 % as bi-racial, and 1 % as Asian/Asian-American. The majority of the student are eligible for Free and Reduced-Price Lunch (90 %) and speak a language other than English at home (93 %). A subgroup of Program C's grades 3–8 students participated in this project.

Data collection and analysis

Virtually (via Zoom), 5 focus groups (with 2–5 people) and 10 individual interviews were conducted in January to April 2022. Whether the staff and youths participated in a focus group or interview were strictly a matter of logistical convenience. Program leaders helped recruit and select the staff and youths as part of the larger project; no particular recruitment criteria were given other than that the participating staff and youths should reflect their program demographic. Focus groups lasted about 60 min, whereas interviews lasted about 30 min. Regardless of data collection format, each staff was compensated $30 and each youth was compensated $20 as a thank you for their time and insight. This study was approved by the HML Institutional Review Board (IRB#: 945MATH21, 946MATH21, 947MATH21).

The same set of six semi-structured questions were asked to staff and youths regardless of data collection format. An example question in the staff focus groups/interviews was "what do you do to connect with your students"; an example question in the youth focus groups/interviews was "what do math tutors do or say to push you to do your best" (see

[2] Program, staff, and student names are de-identified to protect confidentiality.

[3] Additionally, 1 % of Program A's students identified as another race, 11 % have missing race/ethnicity data, and 9 % declined to state.

Table 3
Focus group/interview questions.

	Staff	Youth
1.	What do you do to connect with your students? *Prompts: Do you ask for and listen to your students' ideas? Do you feel like your students trust you and count on you? If so, what did you do to build your students' trust with you?*	What do math tutors do to make it easy for you to connect with them? *Prompts: Do they ask for and listen to your ideas? Do you feel like you can trust them and count on them? If so, what did they do to build that trust with you?*
2.	What do you do or say to push your students to do their best? What do you do or say to help your students believe in themselves? *Prompt: When they make a mistake, how do you help your students learn from it?*	What do math tutors do or say to push you to do your best? What do they do or say to help you believe in yourself? *Prompt: When you make a mistake, how do they help you learn from it? Do the math tutors treat you differently than other people in your life? If so, in what ways?*
3.	What are ways that you support your students that you may not have mentioned already? *Prompt: How do you help students if they have a problem? Do you tailor your approach to how you build relationships with each student you serve? How do you engage students in culturally responsive ways?*	In what ways have your math tutors made you think differently about yourself? *Prompt: Have they shaped how you see yourself when it comes to math?*
4.	What strategies do you use to help your students think differently about themselves? *Prompt: How do you shape their math identity?*	What are ways that math tutors support you that you may not have mentioned already? *Prompt: How do they help you if you have a problem?*
5.	How do you make decisions or figure things out together with your students? *Prompts: Can you share an example of when it's worked well? Do you give your students opportunities to lead?*	How do you make decisions or figure things out together with math tutors? *Prompts: Can you share an example of when it's worked well? Do they give you opportunities to lead?*
6.	How do you support your students in reaching their academic and career goals? *Prompts: Do you support your students in learning new math skills? Do you inspire your students to see possibilities for their future? Do you expose your students to new ideas and/or career paths they had not previously thought about?*	How do math tutors support you in reaching your academic and career goals? *Prompts: Do they support you in learning new math skills? Do they inspire you to see possibilities for your future? Do they expose you to new ideas and/or career paths you had not previously thought about?*

Table 3 for the full list of questions). Additionally, staff (but not youths) participated in an interactive activity where they named factors that made up a strong and positive youth-staff relationship (e.g., trust, laughter, support). From there, the staff arranged and combined what they named into themes. Finally, they ranked the themes from the most to the least important. The focus groups/interviews were semi-structured, meaning that the interviewer at times followed up to ask clarifying questions or prompted participants to elaborate their responses further. The first author and a research assistant conducted the focus groups and interviews.

All focus groups and interviews were audio recorded and transcribed using an online transcription service. In terms of coding procedure, the first author[4] inductively analyzed (Braun & Clarke, 2012) all the transcripts and developed initial codes that emerged as meaningful in contributing to youth-staff relationships. Some initial codes included "build confidence," "competition, games," "share personal stories," and "positive environment." The initial codes were then grouped into themes deductively as guided by the Developmental Relationship Framework, using the definition of the five DR elements and their corresponding actions (see Table 1). This process was iterative where multiple transcripts were re-read and re-coded, especially when comparing and contrasting transcripts from the three different tutoring programs.

Prior to this study, a set of program-specific analyses were completed with findings summarized in similar thematic ways. The findings were shared with program leaders and staff for improvement purposes as part of the larger project, but also served as a gut check to ensure that preliminary themes resonated with the programs.

Findings

Five overarching themes, corresponding to each of the Developmental Relationship Framework elements, emerged on what makes up strong and positive youth-staff relationships in math-learning spaces (see Table 4). Below we elaborate on each theme and their respective relational approaches.

Express care: Relationship building at the personal level as a foundation

To start, both staff and youths emphasized how vital it was to connect with each other on a personal level before jumping into math learning. In other words, a critical aspect of developing positive youth-staff relationships in math learning spaces was simply the time and space to connect as humans, as opposed to connecting as staff versus learners. Some example relational approaches included expressing sincere interest in how things are going outside of the program (e.g., school, home, friends), and leveraging personal knowledge to connect a bit deeper among the youths' interests, such as looking up a youth's favorite anime and making the effort to start a session with that anime's theme song in the background (Staff H). These seemingly small expressions of care on a personal level go a long way to serve as the foundation for relationships and math learnings to develop in the program.

"At least on Mondays, we typically spend the first 30 to 35 minutes chatting with the students, getting to hear about how their days went before actually jumping into the activity or the actual math. I think the core component of Program A is building that family. I wouldn't expect we take 1/3 of the time doing that, but it's proven to be pretty important and plays a very significant role in helping students process what they did at school, allow them to de-stress, and just have a good time. The friendship element has been more significant than I expected and it's been really rewarding." – Staff G.

"I feel like before you can even really get into making math fun or teaching techniques that type of education, you kind of have to connect with your students first to formulate that relationship, which is why we start out with 'get to know you' questions." – Staff F.

Furthermore, an important aspect of expressing care that both the staff and youths acknowledged was attending to emotional needs. Emotional needs can range from asking how the youths were feeling on a particular day, to deeper needs like addressing trauma. By attending to the youths' emotional needs first and foremost, staff positioned themselves as "not just the tutors" (Staff T, see quote below), but as trusted adults who support youths in ways far beyond math. As such, staff recognized that the ways students struggled or thrived in different areas of their lives could, in turn, impact the ways they showed up in math learning spaces.

"One of the things I try to do in every session is to ask them a question about how they're feeling, because how they feel that day determines how the rest of the session's going to go. So whether they're happy, they're tired, I can gauge that mood and create a tutoring session that kind of caters more to how they're feeling that day." – Staff B.

"What makes a positive relationship with students and math tutors is that we listen to them. A lot of the times, kids are going through a lot of things at home. Like one of my students the other day, she broke down crying about 'can you be my mommy?' because her mom passed away last year. Of course, I broke down and I was sitting there crying with her and I told her I will do whatever I need to do with her. So we are not just the tutors, we're sitting there listening to them, trying to figure out what's going on and why these kids are shutting down." – Staff T.

[4] Interrater reliability was not available due to this single coder design.

Table 4
Findings: Developmental Relationships elements and approaches in math-learning spaces.

Themes	Sub-themes	Key example
Express Care: Relationship building at the personal level as a foundation.	• Connect as humans (as opposed to staff versus students). • Attend to student's emotional needs.	*"I feel like before you can even really get into making math fun or teaching techniques that type of education, you kind of have to connect with your students first to formulate that relationship, which is why we start out with like the Get To Know You questions" – Staff F*
Provide Support: Scaffold to meet students where they are at.	• Leverage student's existing math skills and knowledge. • Provide time and space so that students do not feel rushed or judged.	*"I describe him as a really good tutor. He's really kind and he won't just sit there and just go 'meh.' He'll actually help you get the stuff when you need it. I'd always be tired, he'd always let me get that two minute nap that just boost my energy. Then I was able to do what I needed to do. Or if I needed to splash my face with cold water, he'd let me." – Youth C*
Challenge Growth: A growth mindset and encouraging learning environment.	• Provide encouragement and motivation constantly. • Foster a program culture of growth mindset. • Leverage peer dynamics to challenge growth.	*"I never tell them that it's something that they can't do. Just maintaining a growth mindset the whole time and not putting those negative thoughts in the atmosphere, or even in their brain. I know that sometimes even with my tutoring, we look at math like that's hard, I can't do it. But if we don't think about it like that, it was like, let me digest this. Let me take it step by step by step." – Staff D*
Shape Power: Vulnerability and respecting each student's math identity.	• Be open and vulnerable about your own math struggles and triumphs. • Cultivate a balanced, healthy math identity.	*"I try to be really real with the students that math sometimes can be a really challenging subject and those are challenges that I've dealt with. When I was explaining how to manipulate a linear equation in order to isolate a variable, I pointed out a couple of places where I used to really struggle with that took me a long time to understand. I think a little bit of that self-admittance, 'Yeah, this is hard and we all started at a place where it used to be challenging,' I think that helps." – Staff G*
Expand Possibilities: Making math meaningful to real life.	• Use real life examples to explain math. • Connect math to student's potential future aspirations.	*"I try to relate to them by giving the stories about my experiences, I'm still a student and I think it's very helpful for them to know what I went through and see how that lines up with their goals. To give them some advice on what I can, but also asking them what they're interested in and showing them how tutoring and what we're learning can connect to that. Just motivate them to build those goals, to keep their eye on the prize, like, 'Okay, I know why I'm doing this. I'm just doing this math homework because I'm told to but because it's going to lead to me getting what I want in the future.'" – Staff K*

Provide support: Scaffold to meet students where they are

Given how central of a goal learning is in math learning spaces, it is no surprise that a critical aspect of relationship building between staff and youths revolves around providing support. Staff provided support in a collaborative and trusting manner, for example as Youth P shared, "when I make a mistake, she [staff] tells me what to do and she doesn't give me the answer, but she helps me get the answer." Overall, how support is provided can impact youth-staff relationships. We found that staff provided support by meeting students where they were in terms of math learning, and scaffolded their teaching by leveraging what students already mastered to shed light on what they were working on.

"He [staff] gives us a same number, let's say the first one I struggled with is 786 divided by 12, he would keep 786 and change it to another number to see if it makes sense. The better we get at that, he gives us the [harder] question back, and then we get it." – Youth R.

Importantly, meeting students where they were also included providing the time and space that students needed to learn without feeling rushed or judged.

"I describe him as a really good tutor. He's really kind and he won't just sit there and just go 'meh'. He'll actually help you get the stuff when you need it. I'd always be tired, he'd always let me get that two minute nap that just boost my energy. Then I was able to do what I needed to do." – Youth C.

"For the students that struggle with math, something I realized from my own personal experience is that when a teacher helped me through math problems, I would pretend to know what she was doing just to move on. I realized that some students also do that with tutoring, so when a student is really struggling with a problem they can't comprehend it that well, I say, 'okay, we can take a quick break and we'll come back to it'. And that break, even if it's 30 seconds to a minute, I feel like it gives them time to not only process it and think about it a little more, but also come back with an energy that wants to figure it out and wants to know how to do it." – Staff B.

Challenge growth: A growth mindset and encouraging learning environment

Going beyond providing support, another critical aspect of the youth-staff relationship in math learning spaces involved providing encouragement that constructively challenged the youths to grow. This encouragement looked like the staff constantly motivating their students, hitting the 'you can do it' ethos home, because they *genuinely* believe in the potential of the youths. As demonstrated by the quotes below, Challenge Growth involved staff guiding the youths from an initial state of hesitation and resistance to a state of feeling confident and motivated.

"He [staff] encouraged me to work on work problems even though we know that we both hate them. I think it's because of him that I've been able to understand a lot more about word problems because…I don't like having to transition words to math, that didn't work for me. So he just makes it a lot easier by motivating and telling me that I can do it and that I just need to stop giving up and work hard" – Youth A

"I have this student who struggled with math confidence the whole time.

This week I invited her to come to the front and walk the class through a problem. She came up saying, 'I don't even know where to start.' I was like, 'no, you got this. What do these mean?' And she was like, 'oh yeah, it means this. I remember this. It went to that and then to that [solving the math problem].' Then she walked away and it just seemed like she lifted this barrier. We're still working on it, it's not something that just goes away. She has this perception that she automatically can't do something, but if you walk her through it and show her that she can, then she's able to do it and she feels really happy about it." –Staff M

Furthermore, encouraging the youths' math confidence looked like fostering a culture of growth mindset, meaning that mistakes were not frowned upon, but instead leveraged as opportunities for improvement. As Youth L put it simply, "he [staff] always tells me that it's okay if you get the wrong answer. It's because practice makes perfect." That is, emphasizing value statements (e.g., repositioning errors as "okay") is one method of fostering a growth mindset and positive youth-staff relationships.

"I never tell them that it's something that they can't do. Just maintaining a growth mindset the whole time and not putting those negative thoughts in the atmosphere, or even in their brain. I know that sometimes even with my tutoring, we look at math like that's hard, I can't do it. But if we don't think about it like that, it was like, let me digest this. Let me take it step by step by step." – Staff D.

Lastly, to challenge youth's growth and cultivate their math confidence, some staff leveraged the peer dynamic in the space. When asked "what would you say is your favorite thing about Program B?" Youth O simply answered "going against each other, they [staff] make it fun."

"Since I have a close knit of students who have a good relationship with each other, they really like competition amongst each other, like, 'I want to beat Kevin'. So we try to do competitions, all friendly competition, nothing too serious. Sometimes we give them a problem and we all know that they can do it. Everyone in my group is very capable. Just sometimes they need that confidence boost. I'll be like, 'if Cesar can do it, you can do it too. You got it, believe in yourself' and that helps them. They not only get the motivation from their friends, but they also get it from me and it just helps in getting them to have that math confidence." – Staff H.

Share power: Vulnerability and respecting each youth's math identity

In addition to expressing care, providing support, and challenging growth, both the staff and students emphasized the idea of being 'real' (or in other words, authentic) as a critical aspect of their relationships. For example, staff shared their own struggles and triumphs with math in order to empathize and validate what their students are going through. In contrast to the typical adult-student power dynamic that is often assumed, the staff's intentional vulnerability strengthened their relationships with the youths by actively and openly inviting power to be shared. As Staff G explained below, vulnerability, or self-admittance, can be especially helpful in strengthening relationships when youths work on challenging math problems.

"I try to be really real with the students that math sometimes can be a really challenging subject and those are challenges that I've dealt with. When I was explaining how to manipulate a linear equation in order to isolate a variable, I pointed out a couple of places where I used to really struggle with that, and it took me a long time to understand. I think a little bit of that self-admittance, 'yeah, this is hard and we all started at a place where it used to be challenging,' I think that helps." – Staff G.

"They [tutors] tell us about their struggles with school, and we can relate to that because we struggle with school ourselves. We relate to what they do outside their lives, like sports. And sometimes they tell us stuff that happened in school, like their grades, so we get prepared." – Youths Y and K.

Being vulnerable and open was also key to cultivating a balanced, healthy math identity for the youths (i.e., how central math is to who the youths are). Staff validated their youths' individual goals, centered their math journeys, and respected each youth's unique motivation toward and aspiration for math. By centering and honoring each youth's math identity, the staff demonstrated how sharing power was a core aspect of the relationships they built with their youths.

"I always like to reinforce that it's not something you have to like, it's not something you have to want to do. Really naming it out, students are going to like it because they don't feel pressured to have to like it and want to do well in it. 'It's okay if that's a challenge, that's totally okay,' really bringing a lot of affirmation to the fact that you don't have to be perfect at everything. I think also by adding some personal connections to it, 'hey, math might not be your jam, that was me in high school with science. I did not like it; it was not fun for me.' Relating students to that and then telling them how I got through it has also been really helpful because it gives them that motivation to go through it, realizing that they're not the only one struggling with this, even if it's not a subject that they relate to, at least there's a person who understands what it's like." – Staff V.

As the quotes above show, staff were real, transparent, and vulnerable with their youths in validating how they felt about math. In the process, staff built a shared relationship with their youths, as well as promoted healthy relationship between their youths and math.

Expand possibilities: Making math meaningful to real life

The last critical aspect of youth-staff relationships pertains to how staff and youths provide inspiration for each other. On one level, staff inspire their students by connecting the math they learned to their real lives, for example, by using real-life examples to explain a complex, abstract concept.

"Students sometimes get frustrated, 'what is that, why do we really need it?' so when I can tell that they're getting frustrated about math because of the concept, I try to take it a step back. Instead of showing them the question, I give them a real world example. Being able to do that really helps them understand why math is important. I think that's really good to allow connections between what you see on paper and what you see in real life." – Staff H.

On top of making connections between math content and real-life examples, staff also inspired the youths by connecting math to potential future aspirations (e.g., job, studies). To do so, staff and students had candid discussions about how math connects, or does not connect, with their unique math trajectories and future aspirations. Such discussions, making connections between math and real life, played a role in strengthening youth-staff relationships.

"Students say they want to be athletes and police officers and stuff. I'm like 'so you have to get your education in order to go to college or to be a police officer.' To be an athlete, some of them can go without education, but you still want education just for that back. If you'll not make it to be the football lead, you still have your education and still be able to get a good job, because math is in everything, no matter what kind of career you want, it is in everything." – Staff A.

"To support my students in reaching their goal, I try to talk to them not only about math. I ask where they want to go for high school because they are eighth graders and they tell me about their dreams and career prospects. One of them really likes to draw and wants to go into architecture. Another one actually really likes math and wants to go into engineering. I tell them that I'm a college student, I try to give them my two cents about it. I try to get them motivated with my words because they see me as one of their mentors. It just gives them a wider perspective about what they want to do in the future." – Staff H.

Tying it all together, making math relatable to real lives connects directly with staff building relationships with their youths by sharing their personal experiences, empathizing with students' experiences, and connecting on a personal level. Through this process, staff gained a better understanding and appreciation for how every youth's unique personal background influenced their math trajectory.

"I try to relate to them by giving stories about my experiences. I'm still a student and I think it's very helpful for them to know what I went through and see how that lines up with their goals. To give them some advice on what I can, but also asking them what they're interested in and showing them how tutoring and what we're learning can connect to that. Just motivate them to

build those goals, to keep their eye on the prize, like, 'okay, I know why I'm doing this. I'm not just doing this math homework because I'm told to but because it's going to lead to me getting what I want in the future.'" – Staff K.

"I asked him [a youth], 'are you going to go to after school tutoring?' And he said, 'no, I don't. I can't.' I asked why not? I thought he was just going to skip or something, but he said, 'no, I have to take care of my four siblings.' And that's when it hit me. I guess that just gave you a new profound mindset and perspective that these students have so many other different responsibilities. So once I realized that, I took a step back and reevaluated that this is not just about math anymore. This is about how these students have such responsibilities at such a young age and that we really need to help them get to where they want to be no matter what." – Staff H building off Staff R in a focus group conversation.

Discussion

Centering the voices of Black and Latina/o youths from low-income backgrounds, as well as the staff who served them in math out-of-school time and tutoring programs, this study aimed to describe the critical strategies for fostering youth-staff relationships in math learning spaces. We leaned into the Developmental Relationships (DR) Framework as a foundation to understand what relationship-building looks like. Our findings aligned with each of the five pillars of the DR Framework, and went beyond it by adding important nuances that are particularly salient for math. Below, we discuss our findings, one element at a time, in terms of implications for practice (summarized in Table 5) and implications for advancing equity in math.

First and foremost, expressing care at a personal level emerged as a foundation for relationship-building and math learning. Expressing care includes genuinely connecting as humans (rather than as staff versus students) and attending to the youths' emotional needs. These findings yield a range of actionable strategies for math learning spaces, for example from implementing a routine where staff check in with youths emotionally, to equipping staff with trauma-informed practices. The attention to emotional needs is an important addition to the DR Framework because it acknowledges that (math) learning does not happen in vacuum— youths carry their unique stress and strength into the learning space (García Coll et al., 1996). To acknowledge youths' unique stressors and strengths thus means building developmental relationships should be done in a culturally responsive, inclusive, and equitable way. For example, Staff T's quote about expressing care to a student whose mom passed away powerfully showed that culturally responsive, inclusive, and equitable relationship building involves caring for youth holistically—including helping address youth's needs beyond the classroom walls. In this sense, our findings on expressing care highlighted how math learning is much more than instruction, but a skilled craft that balances teaching with emotional work (Williams-Johnson et al., 2022). Trying to teach math without first attending to emotional needs might run the risk of disproportionally alienating youths who already feel marginalized in educational spaces to begin with. In other words, without a relational foundation that is built through authentic and genuine connections, math learning might not yield the intended academic benefit, or might even backfire, particularly for youths experiencing educational systems that often operate in ways that reinforce marginalization (Bayer, Grossman, & DuBois, 2015).

The next critical aspect of youth-staff relationships in math learning spaces is providing support with scaffolds (Moschkovich, 2015). Specifically, staff provided support by leveraging the youths' existing math skills and knowledge to meet them at their respective learning level, as opposed to a one-size-fits-all appraoch. In other words, a core aspect of youth-staff relationships is staff knowing each youth's zone of proximal development and provide supports accordingly. To this point, an actionable implication for math learning spaces is to curate a variety of math tasks/curriculum that range in difficulty so that staff have the resources to meet students where they are at academically. Relatedly, staff also provided support in terms of knowing the right amount of time and space to give their youths so that they did not feel rushed or judged. This finding has implications for advancing equity in math learning spaces as systemic barriers such as stereotypes and discrimination often make certain groups of youth feel more judged or in other way marginalized in math (e.g., Mulvey, Mathews, Knox, Joy, & Cerda-Smith, 2022).

Related to the Challenge Growth pillar of the Developmental Relationships Framework, three relational strategies emerged– constant encouragement, growth mindset, and leveraging peer dynamics. Our findings on growth mindset, or phrased as 'reflect on failures' in the DR Framework, speak to the body of literature on growth mindset in math, including studies that showed significant effectiveness of growth mindset interventions (e.g., Blackwell, Trzesniewski, & Dweck, 2007; Boaler, 2013; Yeager, Hanselman, Walton, et al., 2019). Across the three programs in this study, we found clear evidence that staff are positioned to foster students' productive mindsets toward math learning, which suggests that further programmatic intentionality for equipping staff with skills to develop growth mindsets would be valuable. Our finding about leveraging peer dynamics to encourage collaborative learning

Table 5
Implications: Developmental Relationships elements and approaches in math-learning spaces.

Themes	Practical implications
Express Care: Relationship building at the personal level as a foundation.	• Spend time doing get to know you ice breakers and other relationship building activities before jumping into math instruction. • Show sincere interest in how things are going outside of the program (e.g., school, home, friends). • Implement a routine for staff to check in with youths emotionally. • Equipping staff with trauma-informed practices.
Provide Support: Scaffold to meet students where they are at.	• Work with youth in a collaborative and trusting manner; e.g., help them problem solve rather than giving them the answer directly. • Curate a variety of math tasks/curriculum that range in difficulty to meet students where they are at academically. • Build upon the math skills and knowledge that youth already mastered. • Give youth breaks and in other ways make the learning space comfortable.
Challenge Growth: A growth mindset and encouraging learning environment.	• Consistently encourage youth (e.g., "you can do it") to show that you genuinely believe in them • Celebrate mistakes as opportunities for improvement. • Provide staff with professional development on growth mindsets. • Leverage peer dynamics by gamifying math (e.g., team competitions) and providing collaborative learning opportunities.
Shape Power: Vulnerability and respecting each student's math identity.	• To the extent that staff feel comfortable, encourage them to share their own experiences with math. • Truly listen to the youth and empower them to develop their own math identity. • Encourage staff to validate how their youth felt about math.
Expand Possibilities: Making math meaningful to real life.	• Use real life examples to explain math; adapt lessons to incorporate youths' cultural assets. • Show how math is evident in the job or studies that youth aspire. • Point out how math is involved in youths' day to day. • Bring in guest speakers or materials on inspirational figures that reflect youths' backgrounds.

aligns with prior studies that showed collaborative learning as a particularly critical aspect of math engagement for youths from marginalized backgrounds (Bowens & Warren, 2016; Ukpokodu, 2011; Yu et al., 2022).

Another critical aspect of the youth-staff relationships that emerged was being 'real,' or, vulnerably open. This looked like staff sharing their own math struggles and triumphs, which helped them empathize with their youths, break down power dynamics that might be perceived between an educator and learner, and make their support more genuine—in other words, the staff were sharing power. Often, the dominant narrative in math learning spaces is that one should learn to be better at math, to like math, and to see the value of math. Share Power, as we found in this study, looked like staff centering their youths and respecting their math identity; in the process, the power and autonomy for learning is shifted back to the youths. As such, our findings around Share Power speak to the bodies of literature, for example as guided by the self-determination theory, that points out the importance of youths' sense of autonomy in influencing their math learning and motivation (Hafen et al., 2012; León, Núñez, & Liew, 2015; Niemiec & Ryan, 2009). This finding also has implication for advancing equity in math as it highlights the importance of fostering healthy and strong math/STEM identities for Black, Latina/o, and other students from marginalized backgrounds (Berry, Robert, & Thunder, 2011; Collins & Jones Roberson, 2020).

Lastly, Expand Possibilities is another critical aspect to youth-staff relationships where the staff and students inspire each other by connecting math to lived experiences and future aspirations. This is about making math meaningful *in relation* to their real lives, which is one of the central tenants of culturally responsive relationship building (Gay, 2000; Ladson-Billings, 2002; Nicol et al., 2013; Simpkins, Riggs, Ngo, Ettekal, & Okamoto, 2016). An actionable strategy for math learning spaces is to encourage the use of real life examples– for example through adapting a lesson that resonates with youths' background and uplift their cultural assets (Bottoms, Ciechanowski, Jones, de la Hoz, & Fonseca, 2017; Lipka et al., 2008; Nasir & de Royston, 2013; Song & Coppersmith, 2020). Another actionable implication is to make concrete connections between math and the youths' future aspirations, for example through bringing in guest speakers as role models or materials on inspirational figures and elaborate on how math is involved in their day to day (Gaspard et al., 2021; Gladstone & Cimpian, 2021; Martin & Fisher-Ari, 2021; Yonas, Sleeth, & Cotner, 2020).

Limitations and future directions

It is important to acknowledge several methodological limitations of this study. Firstly, the fact that we did not obtain any staff/youth-level background information limited our ability to more holistically understand the *mechanism* through which Developmental Relationships play out in math programs. For example, literature suggested that youth's duration and reason for participation in math/STEM programs play a significant role in shaping their experiences and outcomes (e.g., Allen et al., 2019; Beymer, Rosenberg, Schmidt, & Naftzger, 2018). Studies that examine how such participation matrices function in relation to the quality of Developmental Relationships formed between staff and youth would thus be a fruitful future direction. As another example, although the programs in this study predominately serve Black and Latina/o youth from low-income backgrounds, we did not collect demographic information such as racial/ethnic and gender identity at the individual staff/youth level. With more nuanced identity information at the individual level, future studies could better understand how Developmental Relationships are cultivated in math programs *and for whom*. In terms of methodology, it is also important to acknowledge that this study's sole data collection method consisted of qualitative interviews and focus groups. Employing more diverse data collection methods, such as program observations and quantitative survey measures, would provide a more holistic understanding of how Developmental Relationships are fostered in math programs. A related limitation of this study is that our data was coded by a single researcher with interpretations checked by program leaders and staff. Having multiple coders, especially those from diverse disciplinary perspectives, with interpretations checked by not just program adults but also youths, could allow the data to be interpreted more holistically.

The participants in this study were Black and Latina/o youths from low-income backgrounds, as well the staff who served them in math out-of-school time and tutoring programs. The staff and youth who participated in this study were recruited by program leaders (as opposed to selected at random), which means their experiences might not be representative of the overall program participants. Furthermore, the participants' lived experiences, especially as it relates to Developmental Relationships and equitable math learning, are not to be generalizable to the general population. In fact, centering the experiences of Black and Latina/o youths from low-income backgrounds is striving for the opposite of broad generalizability, as communities from these historically marginalized backgrounds are still very much underrepresented in the field of developmental psychology (Syed, Santos, Yoo, & Juang, 2018). While our unique sample could be viewed as a methodological limitation, we urge researchers to see it more as a call to uplift the voices that have been historically marginalized yet holds strong potential to advance our understanding of equity.

Finally, the approaches to strengthen Developmental Relationships in math as highlighted in this study are by no means comprehensive. Just like the pursuit for equity is constant and ever-evolving, rather than something that can be checked off, the pursuit for Developmental Relationships is a way of being that requires constant adaptation depending on the context and community served. In other words, it is impossible to ever come up with a "complete" list of approaches to strengthening Developmental Relationships. Rather than seeing this indefiniteness as a limitation, we urge practitioners and researchers to lean into the indefiniteness as potentials to further understand contextual and developmental nuances.

Conclusion

Strong and positive youth-staff relationships are a core component of high-quality math learning spaces and have substantial potential in addressing the systemic inequities in math. Guided by the Developmental Relationships Framework and centering the voices of Black and Latina/o youths from low-income backgrounds, as well as the staff who served them in math out-of-school and tutoring programs, this study offered actionable strategies for fostering youth-staff relationships. Specifically, our findings highlighted the importance of 1) building personal, genuine relationships as a foundation for math learning (Express Care); 2) providing math and emotional support that meet youth where they are at (Provide Support); 3) cultivating a growth mindset culture through constant encouragement and leveraging peer dynamics (Challenge Growth), 4) fostering healthy math identities through being 'real' and vulnerable (Share Power); and 5) making math meaningful to youths' real lives and future aspirations (Expand Possibilities). Taken together, our findings showed that math learning occurs in a context that is both amenable to, and supportive of, the formation of Developmental Relationships. Overall, this study took a nuanced look at Developmental Relationships in math learning spaces, which has implications for making math more relatable and enjoyable for youth who are disproportionately marginalized in the field, thus advancing equity for the broader STEM fields.

CRediT authorship contribution statement

Ta-yang Hsieh: Writing – review & editing, Writing – original draft, Resources, Formal analysis, Data curation, Conceptualization. **Jeehye Shim Deogracias:** Writing – review & editing, Resources, Data curation, Conceptualization. **David C. Parker:** Writing – review & editing,

Resources, Data curation, Conceptualization. **Sandra Morán Pulles:** Writing – review & editing, Resources, Data curation, Conceptualization. **Lauren Rice:** Writing – review & editing, Resources, Data curation, Conceptualization.

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Data availability

The data that has been used is confidential.

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