Urban Education

Urban Mathematics Teachers' Formative Learning Experiences and their Role in Classroom Care Practices and Student Belonging

Journal:	*Urban Education*
Manuscript ID	Draft
Manuscript Type:	Article
Keywords:	Teacher beliefs < Scale Construction, teacher identity, belonging, achievement motivation, mathematics education

Abstract:	This mixed-methods study examines the formative mathematical experiences of twelve urban teachers serving Black and Latinx adolescents. Semi-structured interviews allowed teachers to reflect on their formative learning experiences, structured classroom observations assessed their classroom care practices. Finally, their students' (n=329) mathematics achievement and sense of belonging were collected. Results showed teachers who discussed the role of people-support in their formative reflections were more likely to possess a critical consciousness on the systemic inequity and enact empathetic care patterns. These classroom care patterns mediated the relation between their formative experiences and their students' sense of belonging and mathematics achievement.

Abstract

Mathematics teachers' pre-teaching experiences as mathematics learners likely impact their identity and practice in supporting their own students' learning and motivation in mathematics. However, there is little empirical data on teachers' formative experiences to guide these assumptions, particularly how teachers draw on these experiences when teaching, motivating, and caring for underserved students of color. This exploratory sequential mixed-methods study examines the formative mathematical experiences of twelve teachers currently serving Black and Latinx adolescents in neighborhoods with concentrated poverty. Semi-structured interviews allowed teachers to reflect on their formative experiences in mathematics, structured classroom observations assessed their classroom care practices, and questionnaires and a standardized mathematics assessment were used to examine their students' (n=329) mathematical outcomes. This integration of methods provided three levels of inquiry for triangulation and interpretation. Results showed that teachers developed an ethic of perseverance through their formative experiences, which closely tied to their mathematics identity. However, teachers' perceptions on what enabled them to persevere through challenges as students (i.e., people-support vs. personal-initiative) revealed clear differences in the emotional and instructional support techniques they provided and their students' sense of belonging in their classrooms. Teachers who discussed the role of people-support in their formative reflections were more likely to possess a critical consciousness on the interpersonal and systemic forces that work against Black and Latinx adolescents and enact empathetic care patterns. Further, their observed classroom care patterns mediated the relation between their formative experiences and their students' sense of belonging and achievement in mathematics.

Keywords: teacher beliefs, mathematics education, achievement motivation, teacher identity, belonging, urban education

Urban Mathematics Teachers' Formative Learning Experiences and their Role in Classroom Care Practices and Student Belonging

Conventional wisdom would suggest the formative learning experiences of teachers prior to entering the teaching profession likely impact their teacher identity and how they engage their students. While this might seem obvious, there is surprisingly little research on how pre-teaching formative experiences relate to teacher practice and effectiveness. Ball (1988) argued the most effective way for teaching pre-service teachers is not to treat them as blank states, but to understand whom they were as learners, taking into account the knowledge and personal experiences they bring with them into teaching. Since Ball's admonishment, nearly thirty years ago, the field has made modest progress in understanding the content and pedagogical knowledge teachers "bring" from their personal history into classrooms. However, we still know little about how formative experiences frame teacher beliefs, and how teachers apply these experiences when teaching, motivating, and caring for students of color who tend not to share their same culture, socioeconomic standing, or social privileges. Teachers also possess lived experiences that can influence how they perceive historically underserved groups, which may inoculate them from a deep and critical understanding of the interpersonal and systemic challenges facing students from oppressed environments.

While understanding teacher experiences and beliefs can be challenging for teacher educators across all fields, hardly in any domain are these issues as palpable as in mathematics education. Many of today's mathematics teachers were educated in pedagogical traditions that starkly contrast with the current pedagogies called for by researchers, policy stakeholders, and contemporary curricular standards (Schoenfeld, 2004). Within the past twenty-five years, the National Council of Teachers of Mathematics (NCTM, 2000) has moved to reform traditional mathematics education practices to accommodate the learning needs of an increasingly diverse student population nationally, particularly for underserved students of color. Different from the traditional emphasis on rote procedural knowledge and abstract reasoning, which most of today's mathematics teachers experienced as students, current pedagogies advocate building students' agency, authority, and identity in mathematics, and call for use of instructional methods that involve inquiry and discovering the value of mathematics through real-world problems (Schoenfeld, 2014). Implicit within these reform initiatives is an increased focus on students' culture (Authors, Blinded), socio-emotional and critical consciousness (Bartell, 2011), and on building student-teacher relationships through caring classroom practices (Battey, 2013).

In light of these issues, the present study uses an exploratory sequential mixed-method design to examine the formative school and mathematical experiences of 12 teachers currently teaching Black and Latinx adolescents in an urban district with concentrated poverty. My research questions were:

Exploratory Question 1: How do urban mathematics teachers frame their formative experiences as mathematics learners prior to becoming teachers?

Exploratory Question 2: How do urban mathematics teachers' formative experiences relate to their current teacher identity and beliefs about what their students need in order to be successful in mathematics?

Deductive Question 3: Do urban mathematics teachers' formative experiences relate to their observed classroom care practices?

Deductive Question 4: Do urban mathematics teachers' observed classroom care practices mediate the relation between their formative experiences and their students' sense of belonging and achievement in mathematics?

In exploratory sequential mixed methods designs, the qualitative phase, aimed at unearthing and exploring phenomena, usually precedes the quantitative phase, which focuses on testing the qualitative findings more broadly to establish validity and generalizability (Fetters, Curry, & Creswell, 2013). Using semi-structured interviews, I first probed teachers' experiences as former mathematics students, also inquiring about their desire to teach mathematics in an urban district for students of color. I also probed how they believe learning happens in mathematics and what it takes for students to be successful in mathematics. Second, I conducted structured observations of each of these teachers' classrooms in order to examine their classroom care practices and explore connections between these practices and their formative mathematical experiences. Last, to cross-validate the emergent patterns from the teacher interviews and classroom observations, students' sense of belonging within these same mathematics classrooms was measured via survey and a standardized mathematics assessment.

Theoretical Framework: The Dynamic Systems Model of Role Identity

Teacher identity involves the teacher's comprehensive conception of who he or she is as a teacher (Beijaard, Meijer, & Verloop, 2004). Identity frames interpretation of experiences, informs conceptions of the teaching profession, and guides decision-making during teaching (Beauchamp & Thomas, 2009; Beijaard et al., 2004). Scholars consider teacher identity to be dynamic, complex, and continuously emerging, involving characteristics of both the person and context, and comprising sub-identities that can be more or less harmonious with each other (Beauchamp & Thomas, 2009; Beijaard et al., 2004). Consequently, I adopted an integrative model of teacher identity to guide the investigations in this study: the Dynamic Systems Model of Role Identity (DSMRI; Kaplan & Garner, 2017).

The main unit-of-analysis of the DSMRI is the role identity—the person's network of subjective beliefs and perceptions that define for themselves and others who they are in a certain socio-cultural role (Burke & Stets, 2009; Kaplan & Garner, 2017). Drawing from social-psychological, socio-cultural, and psychosocial perspectives, the DSMRI conceptualizes the person's role identity as a complex and dynamic system of beliefs, perceptions, and emotions that underlies role-related action—the behavior and its meaning to the actor occupying the role (Bruner, 1990). This system that underlies the emergence of role-related action includes four interrelated components: (1) ontological and epistemological beliefs, (2) purpose and goals, (3) self-perceptions and self-definitions, and (4) perceived action possibilities.

Ontological and *epistemological* beliefs refer to the actor's beliefs concerning how the world works. Ontological beliefs concern what the person holds to be true about reality (e.g., math success comes through repetition), while epistemological beliefs refer to the person's beliefs regarding the absoluteness and credibility of the source of knowledge (e.g., I'm confident math success comes through repetition, because I experienced it myself). *Purpose* and *goals* refer to the actor's endorsement of the purpose for their role (e.g., teachers should facilitate academic success among their students) and the specific goals they adopt in particular role-related contexts (e.g., I want every student in my pre-algebra class to earn above C+). *Self-perceptions* and *definitions* are the actor's sense of self-concept, personal confidence, and knowledge relevant to the role (e.g., I've always been gifted at math, so becoming a math teacher was a natural choice), as well as other role-related self-perceptions such as personality traits (e.g., I'm detail-oriented), personal values (e.g., the teacher is the knowledge authority in the classroom), or group memberships (e.g., I'm the only African American female in the math department). *Perceived action possibilities* are the actor's perceptions of actions available to him or her in the role, particularly those that promote the purpose/goals of the role, in light of their ontological and epistemological beliefs, and self-perceptions. For example, a mathematics teacher may perceive worksheets and drilling students as a viable action possibility if they have the ontological belief that success comes through repetition and perceive themselves (or the textbook) to have mathematical authority in the classroom.

The DSMRI conceptualizes that the four role-identity elements, their relations, and the consequences of role-related action also elicit individual emotions. For example, a teacher may have multiple goals for their class (e.g., have all students achieve-well and enjoy the value of math); however, if there is misalignment between these goals and the consequences of the action (e.g., my students hate math because of the drilling and worksheets); the teacher may understandably experience frustration. However, alignment between self-perceptions (e.g., I have an engaging personality), goals (e.g., promoting students' interest in mathematics), and ontological beliefs (e.g., students value math when they see it in their own life) would likely be associated with satisfaction or pride. In the DSMRI, role-related negative emotions can promote identity exploration, as the person is motivated towards identity coherence and will seek to reconcile role identity disharmony between beliefs and outcomes (Kaplan & Garner, 2017).

The DSMRI not only conceptualizes that role identities form continuously within the contexts which an individual lives and works, but also builds on role-related experiences from their past. Thus, teachers' role identity in the classroom will incorporate content (i.e., ontological & epistemological beliefs, purposes & goals, self-perceptions & self-definitions, and perceived action possibilities) from role identities that they occupied in the past that have relevance with their current teacher role identity; for example, their previous role identity as a student.

Teacher Care, Critical Consciousness, and Student Belonging

Core to the DSMRI framework is the individual's *action* in the role identity (i.e., the behavior and its meaning to the actor; Bruner, 1990). In this study, I focused on processes underlying the actions that manifest *teacher care* (Noddings, 1984, 1992, 2006). Teacher care reflects a concern and investment in the child's welfare (Noddings, 1984), as well as efforts toward inclusion, fairness, and seeing equal worth in children (Gilligan, 1982). However, given the current context and sample for this research, I go beyond colorblind notions of care (Thompson, 2004) and investigate teachers' caring practice that support mathematics learning for underserved students of color (Bartell, 2011; Rolón-Dow, 2005). This type of care involves a critical consciousness (Valenzuela, 2016), which underscores how educational institutions in the U.S. have reproduced, reified, and normalized inequality and racism through their structures, curricula, and policy. Further, critical consciousness recognizes how teachers escort bias into their classrooms through their internalization of these racist structures, curricula, and policies in education; ultimately perpetuating disservice for historically disenfranchised students of color. Therefore, teacher care in light of critical consciousness includes a cultural responsiveness that reflects "concern for the implications [a teacher's] work [has] on their students' lives, the welfare of the community, and unjust social arrangements." (Ladson-Billings, 1995, p. 474). However, this work remains mostly theoretical, with little empirical work validating its effectiveness for disenfranchised students specifically. The empirical work that does exist focuses on teachers' definitions and exemplars of caring with critical consciousness (Bartell, 2011; Rolón-Dow, 2005; Ware, 2006), but virtually no work corroborates this with students' mathematical outcomes.

Generally, students can experience a host of social-emotional and academic benefits when they believe their teachers care for them (Thompson, 2004; Ware, 2006). However, for disenfranchised children of color, teacher care may take on heightened significance. Noguera

(2003) showed that although Black American students had high levels of educational aspirations and value, they also had the lowest perceptions of teacher care, and thus low effort expenditure. Further, many teachers are unconscious of or unwilling to acknowledge how hegemonic forces play out in mathematics classrooms, such as low teacher expectations, rigidity in how mathematical intelligence is assessed, lack of curricula and instruction that reflect students' interests and culture, discriminatory behavior management practices, and whether students are given voice as contributors in the classroom. Altogether, these issues begin to wage an assault on students' sense of belonging in mathematics and as mathematicians.

While sense of belonging has been broadly established as essential during adolescence (Lerner et al., 2005), there is evidence to suggest the unique relevance of belonging for historically disenfranchised adolescents. The marginalized existence of Black American and Latinx youth throughout U.S. educational history (e.g., Plessy v. Ferguson, Desegregation turmoil of the 1960-70s, Serna vs. Portales) has perpetuated systemic inequities, psychological stigma, and stereotypes that persist even today, straining a sense of school belonging for these groups. Empirical data corroborates this, documenting the unique academic effects of belonging for Black American and Latino youth compared to other ethnicities (Author-b, Faircloth & Hamm, 2005; Singh, Chang, & Dika, 2010). Further, scholars have linked sense of belonging for historically disenfranchised adolescents to teacher classroom practices and teacher-student relationships specifically (Osterman, 2010). However, these relationships still require empirical support within the domain of mathematics.

In summary, I employed the DSMRI as a framework to investigate the role of mathematics teachers' formative experiences as students for their current identity as urban mathematics teachers and in their classroom caring practices, specifically caring practices that enact critical consciousness. I employed teacher interviews, structured classroom observations, and student assessments to investigate the corroboration of teachers' formative experiences and role identities with their care practices, and their students' belonging and achievement.

Methods

Sample and Procedure

Fifteen middle and high school mathematics teachers across five schools participated in the current study. This data comes from a longitudinal project that examined motivation in mathematics among urban adolescents. The mathematics teachers were those whose students participated in the larger study. The district from which the students and their teachers were sampled was a large city located in the northeast United States. Over fifty percent of residents in this city identified as Black/Black American and approximately one-third as Hispanic/Latino. One quarter of the population was living at or below the poverty line (U.S. Census, 2010).

Five schools and their administrators were recruited and agreed to participate in the study. Two schools were K-8 schools, two were high schools, and one was a secondary school with grades seven through twelve. Across all five schools, over 85% of the students were eligible for free-reduced lunch. After the Institutional Review Board at the PI's university and school district gave permission to conduct the study, in-person announcements were made in all of the mathematics classrooms across the five participating schools. Participating students returned parental consent forms as well as signed an assent form. The student response rate was approximately 64%. At the beginning and end of the school year, participating students took an online survey with scales measuring a host of teacher, classroom, and motivational perceptions.

The teachers of each of these classes also participated in the study via semi-structured interviews and observations of their mathematics classes. All of the teachers agreed to classroom observations and signed for consent; two teachers declined the interview and one left the school before she could be interviewed, resulting in a final sample of 12 teachers for whom interview, observational, and student data was collected. Table 1 presents the teachers' background characteristics. All student, teacher, and school identifying information was protected at all stages of data collection.

Data Collection

Teachers' role identity constituted the main unit-of-analysis; therefore, teacher interviews provided the primary data for discerning teacher role identity, the role of their formative experiences in their teacher identity, and their classroom practice. Next, structured classroom observations of teachers' classroom practice provided triangulation for the themes from the interviews. Last, survey and achievement data from the students within these mathematics classrooms were analyzed for a second level of triangulation with the analysis of the interviews and the classroom observations.

Teacher interviews. The author and a research assistant conducted semi-structured interviews with 12 mathematics teachers. The interview protocol was designed to capture the interplay between the teachers': a) recollection of their formative experiences as mathematics students and its role in their current self-perceptions and definitions as mathematics teachers, b) ontological beliefs about the nature of critical thinking and mathematical reasoning among their students, c) beliefs about their students' cultural background, and critical consciousness, d) goals for their students, and e) action possibilities for instructional practice.

Classroom Observations. The Classroom Assessment Scoring System-secondary (CLASS-s; Pianta & Hamre, 2009) is a structured observational protocol used to measure the behavioral and instructional practices of teachers in secondary classrooms. Of particular importance for this study were teacher practices that illustrated care and responsiveness to student. Two dimensions within the CLASS-s framework that represent these practices were *teacher sensitivity* and *quality of feedback*. Teacher sensitivity was observed through four indicators: *awareness* (e.g., anticipating problems, noticing student difficulties), *responsiveness* (e.g., re-engaging students, acknowledging emotions, adjusting instruction), *helping students resolve problems*, and *student comfort* (e.g., students take learning risks, free participation). Similarly, quality of feedback was observed through four indicators: *feedback loops* (e.g., back-and-forth exchanges, persistent follow-up questions), *scaffolding* (e.g., hints, prompts for thinking), *building on student responses*, (e.g., clarifying or expanding on student responses), and *affirming students* (e.g., recognition of effort, encouraging persistence). These indicators scaled from one (low) to seven (high).

All math classrooms were observed for a minimum of seven cycles from November through March of the school year. A cycle consisted of 30 minutes of observation and coding. There were two observers in each classroom per cycle, and the final observation score for each cycle was the average of the two observers' scores. This method produced an inter-rater reliability of r=.91 across nine coders. Prior to entering classrooms, all coders received extensive training on coding procedures with over 15 hours of focused instruction and video practice, as well as a final assessment to ensure the reliability of each coder. Although the CLASS-s is a structured and quantitative observation system with predefined dimensions, the coders were also trained to take field notes across these dimensions to illustrate, with rich examples, the classroom dynamics that supported the quantitative codes. The coders who observed classrooms did not code or analyze the interview transcripts, which the exception of the author who analyzed the majority of the interviews but participated in <20% of the observation cycles.

Student belonging. In the fall and spring, 329 students completed ten items measuring their sense of belonging in their mathematics classroom (e.g., "*I feel like I belong in my math class at my school*," "*Compared with most other students at my school, I am similar to the kind of people who succeed in math*"). These items were on a 7-point scale (1= Strongly Disagree; 7=Strongly Agree) and adapted from the *Sense of Social and Academic Fit in STEM* scale (Walton, Logel, Peach, Spencer, & Zanna, 2015), which was validated with a sample of undergraduate engineering majors (∝=0.87). Despite the difference in sample and the adaptation to mathematics specifically, the scale maintained strong internal consistency for the current sample in the fall (∝=0.81) and spring (∝=0.77). In a confirmatory factor analysis, the scale demonstrated adequate fit χ^2= 47.23 df = 20, p<.001; CFI = .95, TLI = .93; SRMR = .04; RMSEA = .07 [90% CI .05, .10]; however, two reverse-coded items on the scale loaded very poorly and were ultimately dropped from future analyses. The retained eight item measure correlated to the original 10 item measure r=.96 in both the spring and fall. The measure also showed good construct validity with a scale measuring mathematics efficacy from social persuasion (r=.54) and mastery experiences (r=.47; Usher & Parajes, 2009) in the same sample.

Student mathematics achievement. Student attendance and standardized mathematics scores were obtained from the district with the permission of parents/guardians. The maximum possible days of school attendance was 183. The state assessment, Partnership for Assessment of Readiness for College and Careers (PARCC), measured standardized mathematics achievement. The PARCC assessment has been adopted by nine states, including the District of Columbia, as the statewide yearly assessment for grades three through eight and high school. The mathematics portion is scored out of 850 points with five tiers of performance ranging from "did not meet expectations" to "exceeded expectations." It has been found to align with common core and state standards, predict remedial college math, and predict college readiness comparable to the Scholastic Aptitude Test (SAT) and the National Assessment for Educational Progress (NAEP; Nichols-Barrer, Place, Dillon, & Gill, 2015).

Data Analysis

The analysis of interviews followed the constant comparative method. The constant comparative method considers pre-existing theory (i.e., DSMRI) alongside insights from the data to generate a new theoretical understanding of a phenomenon (Glaser, 1965). This method involves comparing certain meaning-units (e.g., an incident or theme) with all others in order to understand the relations between various meaning units for constructing a comprehensive conceptual understanding of the entire data set. The combination of deductive theory-informed categories with inductive themes surfacing from the data lead to a set of enriched categories, conditions, consequences, and processes that provide both description and explanation for the phenomenon of interest (Lincoln & Guba, 1985).

The narratives from the transcribed interviews were divided into meaning-units (e.g., an event, a theme) by organizing the data from each interview into categories. Second, through axial coding, the codes were grouped to reflect larger themes, which allowed for a comparison of codes and themes across teachers (Strauss & Corbin, 1998). Third, emerging themes of interest (e.g., experiences as math learners) were prioritized and compared across all their appearances, leading to similarities, differences, and extensions among the focal study constructs (Boeiji, 2002). Finally this lead to the development of two formative profiles. Structured classroom observations were then analyzed to corroborate the validity of the formative profiles.

The means from the classroom observations were compiled for each individual teacher. Based on the two formative profiles that emerged from the interview data, teachers' observation scores were collapsed into one of these profiles and the means for each profile were compiled. These means represent 15 teachers[1] and the 34 mathematics classes those teachers taught. In addition to means, qualitative descriptions of classroom incidences and practices were also reported to illuminate the context and meaning that supported the observational codes. Finally, students in these mathematics classrooms reported their sense of belonging to corroborate the teacher interviews and observational data.

Student survey data measuring belonging, as well as their achievement scores, were compiled for the mean, which were then collapsed into one of the two profiles, based on the profile that the teacher who taught their mathematics class was most closely matched to. Thus, a binary variable was computed representing two profiles, and was used to predict differences in the observed classroom care practices (i.e., mediator) en route to predicting student belonging and mathematics achievement using mediation analyses via structural equation modeling.

Integration. Beyond simply using multiple methods, integration can enhance the quality and value of mixed methods research (Creswell & Plano Clark, 2011). In this study, integration occurred via *connection* (Fetters et al, 2013) at the sampling stage, where students were initially recruited for surveying in a larger study, then the teachers of these students were sampled for exploration of the main concepts in the present study (i.e., formative experiences and teacher identity). Last, the student sample was revisited to validate the themes in the teacher interviews.

During the reporting and interpretation of results, the qualitative interview data was presented first. Next, the qualitative and quantitative data are *weaved* (Fetters et al, 2013) during the presentation of the classroom observation findings; since the observation data consists of both structured observations and extended qualitative notes on those observations. The teacher

[1] This includes the three teachers for whom there was no interview data, but observational data. These teachers were not collapsed into a profile; however, their classroom observation data was still used to increase the observational sample size and use as a comparison to the other teacher profiles.

interviews were also brought into this weaving stage for instances in which teachers may have explained classroom processes that were also directly observed. Third and finally, student survey and achievement data were presented through a process (i.e., mediation) model; however, this also included a variable that represented the quantification of the themes that arose during the teacher interviews (as known as *data transformation*; Fetters et al., 2013). An inherent limitation in quantifying qualitative data is reducing its initial complexity. In this study, the two profiles most likely represented two potential points on a broader continuum; however, quantifying these profiles reduced them to two mutually exclusive profiles. However, the advantage of this quantification was the ability to test the validity and predictiveness of these teacher profiles by relating them to other observed and measured constructs.

Positionality

I have reflected on my positionality in this research and the role that might have played on the data collection and findings. The two interviewers in this study were people of color with critical perspectives on the role of race, poverty, and systemic discrimination in U.S. K-12 education. We were also outsiders to these school communities, known as academic researchers. Hence, our status, race, and personal beliefs may have influenced the content and direction of the interviewees' responses, particularly for white teachers who might have been uncomfortable discussing topics of race and discrimination, as well as for teachers who may have wanted to appear socially conscious due to social desirability bias. In light of this, we were intentional about practicing sound interviewing protocols, eliminating biased questioning, probing, or gesturing, and taking notes on instances where interviewees may have done or said something that reflected they may have felt threatened or negatively evaluated by us.

Results

The majority of formative experiences the mathematics teachers cited as students could be reduced to a few pivotal incidents and/or a few core characters. The dominant theme that surfaced through the analysis was memories of *perseverance* through rigorous mathematical problem solving. Within this theme, teachers also reflected on sources of motivation that enabled them to persevere through their most challenging seasons as a mathematics learner. In these reflections, some teachers mostly focused on key individuals (e.g., teachers, mentors, parents) who helped them persist through difficult times in mathematics. I coined this theme *people-support*. Conversely, other teachers discussed a self-initiated attitude or effort shift that was instrumental in their perseverance. I labelled this theme *personal-initiative*. Next, teachers' articulation of people-support versus personal-initiative experiences revealed clear differences between their care practices (i.e., teacher sensitivity and quality of feedback) as observed in their mathematics classrooms. Last, students displayed statistically significant differences in their sense of belonging and mathematics achievement based on whether their class was led by a teacher who reflected on predominantly people-support versus personal-initiative experiences as a mathematics learner.

Qualitative Interview Themes

Reflecting on their experiences as former mathematics students, one of the most clear and consistently cited themes that emerged from the teachers was one I describe as the *perseverance ethic* of mathematics. Nearly all the teachers described mathematics as a puzzle or cognitive challenge to be wrestled with; however, they intrinsically enjoyed this struggle, especially the feeling of satisfaction produced once they had persevered through the difficulty. This perseverance ethic seemingly branded them as mathematicians, revealing alignment between ontological beliefs (i.e., mathematics is about rigorous problem-solving) and self-perceptions (i.e., overcoming difficult problems makes a person exceptional, a mathematician) to produce positive emotions that reinforce their mathematics identity (Kaplan & Garner, 2017).

> So it was fun! I always look at it as puzzles and understanding logically where everything fits in. And since the grading of math is completely objective... Well, I just felt like in most cases there has to be an answer. So instead of giving up right away, just continue to persevere until I am able to accomplish what I'm setting out to do. So whether that's finding a job or completing an assignment in a different class, I kind of go back to math. Like, 'Okay, well it works here. So it should work everywhere else.' (Mr. Tobe)

Like Mr. Tobe, many teachers discussed this perseverance ethic as a lens for tackling challenges in other areas of their life. Combined with a sense of self-efficacy in problem solving, Mr. Tobe was able to transfer his ontological beliefs about the nature of mathematics (e.g., always an answer) to domains outside mathematics. Ultimately, this also allowed for well-rehearsed action possibilities (e.g., confront challenges adaptively) and a sense of purpose. Mr. Espada made similar connections through his reflections.

> I think when I was able to connect the dots of math and problem solving. Cause let's say I have a situation. It could be with school, it could be with a girlfriend…, it could be with my schedule. Anything! I feel as though math helps you look at all the variables in front of you and how you can determine the outcomes of it. So when I connected those two dots, and honestly it was probably in high school, that's when I was like, 'Oh, shit!' … It was like a brain growth for me. It not only helped me with my grades, but it also helped me with real life situations. (Mr. Espada)

The robust nature of this theme was striking. These data did not suggest this ethic of perseverance was an indicator of highly effective or competent mathematics teachers. Rather, the ethic seemed to traverse teacher quality, gender, years of teaching experience, and socio-economic upbringing. However, while there was little to suggest distinctions across teachers within this theme, there were subtle indications that this ideology distinguished them from other "ordinary people" who were not "math people" or those who did not appreciate rigorous thinking. In other words, true "math people" always persevered in logical thinking and relentless problem solving, separating them from other types of people, and branding them as exceptional and even in some cases as strange. Mr. Todd illustrated through his epistemological evidence for his self-perceived affinity for mathematics and subsequent emotions of euphoria.

> I found that I enjoyed doing the problems. I liked the way it made, uh, and people laugh at me when I say this. I like the way it made my brain feel... Let's see the best way I can describe it is the environment to the gym or working out, and afterwards you get that really good feeling that you worked it, that's what it feels like... It made me feel good up here [*pointing to his head*] when I was using my brain, but there was also that sense of accomplishment when I completed a problem." (Mr. Todd)

Seasons of crisis in mathematics: People-support versus personal-initiative. The perseverance ethic of mathematics, described above, assumed persistent and perpetual challenges as a part of emergent identity in mathematics and even overall growth as a person. However, while these teachers relished their experiences of having overcome many math challenges and being better for it, each teacher also reflected on seasons of difficulty so extreme, they doubted whether they wanted or would be able to persist in mathematics. These seasons of crisis occurred at different stages for these future mathematics teachers, ranging from pre-algebra in middle school to college-level calculus. The type of crisis also varied: some experienced frustration from underperformance, while others tried to overcome perceptions of the irrelevancy of mathematics personally. As the teachers reflected on these difficult seasons in mathematics, the first distinctions within the perseverance theme became evident; namely, differences in how these future teachers believed they ultimately "made it" through their crises in mathematics[2], through people-support or personal-initiative.

People-support. Six teachers (Mrs. Evans, Mrs. Emmett, Mrs. Ellena, Mr. Espada, Mrs. Brenda & Mrs. Bairos) recalled remarkable allies that cared for and supported them during their seasons of difficulty with mathematics. These allies opened up the world of mathematics for

[2] Two teachers were difficult to categorize according to the trends discussed in this section (Ms. Talbot, Mrs. Badowski). These teachers lacked detail in discussing math crises/difficulties or sources of perseverance throughout their experiences as mathematics students.

these future teachers during difficult yet formative seasons and taught them insights into understanding and conquering mathematics. Mrs. Evans considered herself a prime example of the impact of people-support, which seemed to have translated into her own teacher role identity; where she hoped to provide the same support for her students.

> And so I want to be like what Ms. W**** was to me, even though, at the time, I didn't know I would love math. But she opened it up where I felt as though, 'I could do this, okay.' So I want to be that type of student, I mean that type of teacher, to those students like she was to me in the same neighborhood… She just made everything so easy. I think that's why I like algebra so much. (Mrs. Evans)

Her "Freudian slip" here may not have been accidental; rather, it could have suggested a subconscious transferring between her prior student role identity to her current teacher role identity, indicating alignment between her ontological, epistemological and purpose beliefs (Kaplan & Garner, 2017).

Further, in reflecting on her neighborhood as a former student and where she now teaches, Mrs. Evans challenged the stigma associated with her impoverished neighborhood, saying "you can actually get what you need." However, she believed that what students need is ultimately found through allies, an epistemological belief consistent with her own experience.

> I guess it's like sentimental, a little bit. I didn't go to this school as a student, but I lived in this community. I went to probably a worse school at the time, high school, but I just really feel like regardless of the environment that's surrounding you, you can actually get what you need… you can get information that can help you with your future opportunities. You just have to be able to be willing to accept those people into your life.

Here, Mrs. Evans may possess a critical consciousness (Valenzuela, 2016), acknowledging the oppression the neighborhood suffers, but also rejecting the temptation to consider this adversity as deterministic and prohibitive of her students' potential for success. Thus, she saw her purpose as partnering with students to provide them agency through education and combating unjust social arrangements (Ladson-Billings, 1995) that work against their chances for success. This example also shows how her epistemological beliefs informed her purpose.

Interestingly, these teachers' narratives consistently revealed that *how* these seasons of crisis in mathematics were ultimately resolved (i.e., via people-support) predicted what they assumed about the nature of learning in mathematics and what they hoped to achieve in their own teaching. For example, Mrs. Emmett's mathematics advisor in college challenged her perceptions of mathematics as "stiff and boring" when she was a student. She also found his personality matched her own self-perceived personality, opening new action possibilities for her own mathematics teaching.

> Definitely my advisor in college was a big influence, I try to emulate him… people tend to think that math is boring. But he always brought life to the classroom and he joked, his personality shined as he was teaching, and I was like 'oh so it's not as stiff and boring as my high school teachers that I had', and I have a very jovial personality as well, so I tried to emulate that (Mrs. Emmett)

In conjunction with her college math experiences, Mrs. Emmett also discussed the early support she received from her mother's focus on the mastery and meaning of math content: "My mom was never okay with just grades. She would sit with me like this, and as I'm doing homework she would want me to teach her something that she didn't remember learning. So I got into the habit of making sure I understood just in case… I would have to share it with my mom." Mrs. Emmett also designated the impact of this formative experience on her current pedagogy in the classroom, which is keenly focused on students explaining and justifying their thinking. She also allows opportunities to show different ways of problem solving, and gives voice and agency to students. She said, "…and I bring that 'momma' instinct to the classroom." These examples illustrate how ontological beliefs informed purpose/self-perceptions, which she believes ultimately drives her actions as a teacher

Most of these teachers directly connected significant people-support experiences to their pedagogy and relationship building practices with their own students. In keeping consistent with the perseverance theme, these teachers viewed people-support as the reason why they were able to persevere in mathematics and also how to get their students to persevere. Teachers who cited people-support during seasons of math crisis were also likely to discuss three distinct patterns of *empathetic care*, described in prior research on this same sample of teachers (Authors Blinded). These patterns were 1) emotional consciousness to understand and manage student frustration, 2) affirming student self-identity while engaging mathematics, and 3) partnering with student struggles in mathematics and beyond. These empathetic care patterns were robust across people-support teachers and are consistent with a warm demander pedagogy (Kleinfield, 1975; Ware, 2006), which combines deep caring relationships coupled with tough-minded, disciplined expectations for neglected of marginalized children.

> My philosophy is you got to teach students with love, but you got to be strict with them as well…you can't be like, 'Oh, it's okay. I understand, you don't have your homework.' You have to be strict like, 'You know at the end of the day you need to bring it. I understand we all have our different crisis or what not. Like you can talk to me about it, but I expect it from you.' But it means getting to know the students, getting to know the family, doing whatever I can in order to support them. In any way possible. (Mr. Espada)

In this text Mr. Espada exhibited multiple empathetic care patterns (Authors Blinded), such as sensitivity to students' emotions (pattern 1), and a willingness to partner with students during their difficulties in and outside of school (pattern 3). Mr. Espada's comments also reflected a deep critical consciousness, which was epistemological support for his care practice. He understood students in his class were facing real challenges outside of school that affected their lives inside school. Instead of blaming parents or poverty, he was more focused on finding ways to connect with students' lives outside of school, in order to support them inside school.

Altogether, these teachers acknowledged the importance of the support they received throughout their journey toward becoming a mathematics teacher. More than simply identifying their favorite teacher, these individuals demonstrated the profound and active role their allies had on their own perseverance in mathematics, their teacher role identity, and how they encourage their own students to persevere.

Turbulent profiles within the people-support typology. There were two teachers (Mrs. Brenda & Mrs. Bairos), who while reflecting on the role of people-support in their formative experiences, did not neatly fit into this typology and thus were coined as turbulent examples of this profile. Kaplan and Garner (2017) might describe these individuals as existing in "repellor" states, which reflect instability, disequilibrium, or tension between their multiple beliefs and external experiences. Most significant in these teachers' reflections was a realization of the need for people-support as students without having actually received it. This lack of support created stress, confusion, and self-doubt (i.e., turbulence). Mrs. Brenda reflected on eleventh grade in an algebra II class, where she was falling behind and in need of support.

> I remember being in the class and raising my hand when I didn't understand something and asking the teacher to slow down approximately at a few things and she just wouldn't. She had to cover the material or whatever and because I had difficulty that year I noticed that it [*her algebra difficulties*] showed up again when I got to Calculus.

Interestingly, Mrs. Brenda, as well as Mrs. Bairos, saw their lack of people-support during their season of crisis as pivotal experiences in their personal history. They both believed this negatively impacted their mathematical development and confidence, which seemed to have a ripple effect on their self-perceptions as capable mathematicians currently: "I don't know that I'm a good Math teacher. I'm an okay Math teacher" (Mrs. Bairos). However, these lack of support experiences may have also enhanced their caring practices as teachers, helping them realize the critical nature of people-support for their own students, "I've been cited on my evaluations that one of my strengths is the community environment" (Mrs. Bairos). In other words, through their lack in their own formative experiences, they developed ontological and epistemological beliefs regarding the central importance of people-support for their students.

Personal initiative. Conversely to teachers who reflected on people-support as a source of persistence in their formative mathematics experiences, there were also teachers (Mr. Talleda, Mr. Todd, Mr. Tobe, Mr. Bell) who viewed their season of crisis in mathematics as the turning point where they decided to double-down on their effort and will to succeed. They usually described this as paying more attention in class, spending more time on homework, repetition, focus, and practice. Thus, they attributed their perseverance in mathematics toward their internal grit and willingness to change their effort and engagement. Overall, it is not that these teachers never mentioned the support of others, rather there was a principled and prominent belief by these teachers that the central factors in their math perseverance were derived from inside themselves and on their own desire to "put in the work" they believed led to success. Recounting his difficulties in calculus, Mr. Talleda attributed his improvement toward quitting self-sabotage behaviors and investing more time into homework, studying, and memorization strategies.

> But once you put time into it, do your homework… So for me just to look at the problem, go over it mentally and then work it out at home, it became not hard, you know? … My hardest class was calculus I. I actually became really challenged, I took it twice. My first time… I believe it was a C-, D, high D. But it might be my fault that I didn't put too much time into it. I got into my head, "I know this," you know?
>
> *Interviewer*: Okay. And then what changed the second time you took it?
>
> Put more time into it, you know? Doing assignments, study, put more time into it... (Mr. Talleda)

Mr. Talleda and the other teachers who made attributions to personal-initiative in their own experiences also seemed to transfer those ontological beliefs to their students through their messages and speeches. It also framed how they perceived the mathematical difficulties of their own students as well as how they supported them through these difficulties. The data revealed that for frustrated, stressed, or underachieving students, personal-initiative teachers were more likely to cite self-sabotaging behavior as part of the reason for the problems and redirect these students toward developing internal motivational qualities (e.g., attention-focus, self-discipline, grit, self-confidence) to overcome their shortcomings. Talking about the mathematical performance of one student, Mr. Talleda said:

> I told her, 'Listen, you're a smart girl, you know, but there's just something going on that I don't know what is it, but, you just need self-esteem, you know? Like you need to be confident in yourself, you know? But you got it. You got the stuff. You got it!'

The 'pep-talks' these teachers tended to give struggling students reinforced their ontological beliefs of personal-initiative, drawn from the recollection of their own formative experiences.

> So to me with math, practice makes perfect. I got good at math because I did more than the minimum… For me, I think the students need to struggle a little bit with something instead of me just jumping in and saving them each and every time they come across something difficult …So I think what it comes to, let's see what would I call that, um, self-motivation? (Mr. Todd)

Messages from personal-initiative teachers to students shared commonalities in that they were almost always directed toward activating the student's internal fortitude, infrequently addressed actual mathematical thinking, and rarely sought to understand the antecedents of students' lack of motivation. Similar to what Authors (Blinded) have coined as *transactional care*, these messages took a generic 'cheerleader' quality that wished students well but remained inactive in actually supporting them in becoming successful.

Laden within transactional care and the personal-initiative ideology is the assumption that motivation is purely intrinsically generated, which contradicts much of motivation research in education (Covington, 2000; Deci & Ryan, 2000; Wigfield & Eccles, 2000). For these teachers, motivation is directed by the goal of wanting to do better and the ability to be able to focus that desire into action; therefore, if motivation was lacking, it was because desire and thus effort were lacking. “Unfortunately, a lot of the students in my classes see frustration as an excuse to stop doing the work. They don't persevere through it” (Mr. Todd). Often these teachers neglected to recognize the contextual (e.g., classroom climate), social (e.g., student-teacher relationships), and purposive (e.g., “What does math mean for my life?”) factors that influence student motivation beyond intrinsic desire alone.

Turbulent profiles within the personal-initiative typology. While I present the people-support versus personal-initiative profiles as dichotomies, it is likely that these typologies are indicative of a continuum, with multiple shades of subjectivity and blended formative experiences existing in between. Two teachers in particular (i.e., Mr. Tobe, Mr. Bell) revealed qualities consistent with a personal-initiative ideology, but were considered turbulent profiles within this typology, ultimately showing tension between people-support and personal-initiative beliefs. I present one of these cases, Mr. Tobe, as an exemplar who simultaneously demonstrated instances of both personal-initiative and people-support at multiple points in his development as a mathematics student. As illustrated directly below, Mr. Tobe discussed people-support through his mother’s demandingness; however, he also clearly voiced elements of personal-initiative (e.g., “repetition” “focus”).

> I had my parents or my mom on my back like making sure, she would sit next to me while I did the work; she wouldn’t let me eat, she wouldn’t let me sleep until it got done… I’ve done so many problems and got a lot of practice in. So for me, I know that with a lot of practice, it’s easy…, it’s not that math is difficult, it’s just being able to study and focus and the repetition… the repetitive nature of trying it until you kind of almost memorize how to do everything. (Mr. Tobe)

While acknowledging the academic support and expectations of his mother, Mr. Tobe also suggested this support was instrumental in developing the behavioral patterns that allowed him to be his own support as he developed in mathematics. Ultimately, it was the repetition and practice that he credited for his math success. Further, it seemed his mother's support was not particularly high in warmth (Baumrind, 1966) but more so performance-oriented and authoritarian in nature. This was confirmed through multiple references to his mother throughout the interview. His identity as a child to his mother produced ontological beliefs that high performance was expected but not affirmed, thereby impacting his teacher role identity and restriction of perceived action possibilities regarding caring affirmation for his students.

> I'm not really good with affirmations… and I know that's reflected off of the way I grew up too. Everything was an expectation. So even if I did do well, it was always, "Well, you could have done better," kind of thing. And I understand that's not how all students work, but it's really hard for me to be like "Good job" [to students]. (Mr. Tobe)

However, Mr. Tobe also revealed his perceptions of people-support when he discussed his interactions with his college math professors, in which his own level of motivation in courses corresponded with the level of personal connection he felt he had with the professor.

> I think creating a connection with students is much more valuable. When they feel they're heard, or when they can relate, then they'll be more willing and open to listen to what I'm saying rather than talking to each other during class.
>
> *Interviewer*: How did you come to realize these things?
>
> Uh just through college mostly, you know? I noticed immediately the teachers that I liked. I didn't like them because they were easy, I liked them because of the atmosphere that they created and being available for me to talk after, you know, their office hours, and their encouragement.

Clearly, Mr. Tobe understood the importance of having quality relationships with students. At the same time he felt unable to consistently and authentically enact this knowledge in his own classroom, reflecting a strain between ontological beliefs regarding relationships and his self-perceptions and perceived action possibilities (e.g., I'm not really good with affirmations… it's really hard for me to be like "Good job" [to students]; Kaplan & Garner, 2017). It is possible that the early authoritarian experiences with his mother created tension with more recent experiences of care and connection in college, leading to a conflicted understanding of people-support, care, and relationships without an active teacher practice of these qualities. Mr. Tobe's "you could have done better" authoritarian mindset was clearly at odds with his "connection with students is much more valuable" lived experience. He has not yet found a way to harmoniously integrate high expectations and high warmth into a warm demander pedagogy (Ware, 2006). Mr. Tobe understood care conceptually (i.e., transactional care; Blinded Authors), but this remained inert knowledge, infrequently enacted with his students. Thus he was categorized as turbulent within the personal-initiative typology.

Altogether, the differences in beliefs of what allows for perseverance in mathematics (i.e., people-support versus personal initiative) were generally clear, albeit distinct. Despite this distinction, the links from formative experiences to ontological beliefs, purpose, self-perceptions, and action possibilities seemed consistent across these two typologies. Teachers who discussed the role of caring allies in their own perseverance and mathematical development were more likely to also discuss empathetic care (Authors Blinded) in how they engaged their own students and the necessity of this support for their students to persevere in mathematics. They were also more likely to demonstrate a critical consciousness of the sociopolitical and hegemonic factors that made their support imperative (see examples from Mrs. Baker and Mr. Espada). Conversely, teachers who prioritized the role of personal initiative in their formative experiences were more likely to focus on their students' need for greater internal motivational qualities.

Classroom Observations and Student Outcomes

The previous section provided evidence illustrating the connection between teachers' formative mathematics experiences, their teacher role identity, and beliefs about what their students need to be successful in mathematics. In this section, I present observational and student data to illustrate how those formative experiences and beliefs become visible in classroom practice. Finally, I present evidence to support how teacher experiences, identity, and practice predict students' sense of belonging in mathematics and achievement.

The observational data revealed clear differences in teacher sensitivity and quality of feedback between teachers who primarily endorsed people-support versus personal-initiative in their formative mathematical experiences (see Figure 1). Teacher sensitivity was observed in classrooms through teacher awareness, responsiveness, helping students resolve problems, and student comfort. Overall, people-support teachers were more likely to anticipate and notice student difficulties and adjust their instruction or pacing to re-engage struggling students and create opportunities for deeper learning. For example, Mrs. Brenda took very long and intentional pauses after asking "Are there any questions?!' She later explained,

> Some kids say, 'No!' I don't listen to the no's, I'm looking for the yesses and I'm looking at people's faces and looking for their hand looking like it twitched, like it was going to raise because they had a question. And when someone does feel brave enough to ask the question, state that there may have been other students that have that question as well so that it stays a safe place.

This seemingly simple caring technique protected students' sense of self-worth from the threat of failure. It may also reflect a conscious acknowledgement the personal histories and social experiences of students attending a failing school in a historically failing district where eight percent of students met state standards in mathematics the previous year. Without using this knowledge as a deficit frame against students, she modified her own practice to support them.

Teacher sensitivity, such as described above, often led to valuable opportunities for providing quality instructional feedback to students, which was observed through feedback loops, scaffolding, teachers building on student responses, and affirming students. After identifying wrong answers, misconceptions, or areas of frustration, people-support teachers effectively utilized these instances to facilitate deeper learning opportunities and build on students' knowledge. Mr. Espada used a technique he called *My Favorite No*, where he would engage the class in a discussion where students picked their favorite wrong answer amongst each other, discussed the different ways students chose to solve the problem, and determined the part of the process that might have gone awry for their favorite wrong answer. This practice helped reduce student and teacher infatuation with correctness and mitigated the personal sting of wrongness by disarming and normalizing it.

Similarly, Mrs. Emmett's immediate response to the class after a student finished explaining their thought process on a problem was, "What do we like about the way [student name] solved this problem? What don't we like?" She often asked this regardless of the correctness of the answer. A student responded, "I like that they showed that it's distributive property, but I don't like that they forgot a negative times negative is a positive." Through her follow-up questioning on every student demonstration, she socialized the students to value conceptual understanding over simple correctness. She said, "I always have questions, and follow-up questions, and follow-up questions [*laughing*], so they know it's coming… So we do that together for maybe two questions. And then, they take the lead on the next one. Meaning, they're now the ones asking the questions to each other." Although people-support teachers often provided individual support to students, these quality of feedback techniques were often enacted during large group instruction in order to have multiple students benefit from modelling productive thought processing, explaining and justifying, and understanding common misconceptions.

Comparatively, personal-initiative teachers were less likely to exhibit teacher sensitivity and showed lower quality of feedback. These teachers were more likely to handle student difficulties through triage. Student difficulties often caught these teachers by surprise, which lead them toward becoming more reactive, such as becoming frustrated themselves or trying to troubleshoot students' problems retroactively on a case-by-case basis versus being proactive about the aspects of a concept that might give students trouble. Mr. Todd would often move on quickly from students who could not correctly answer a question, as if giving up on them to find a student who knew the answer. This conveyed that finding the answer to the question was more important than the student who was trying to understand the question and answer. Ultimately, this practice resulted in the same two or three students always being selected and lower overall engagement. Fortunately, Mr. Todd was more likely to give higher quality of feedback to individual students (e.g., scaffolding through a problem on a worksheet) than in whole-group instruction; however, this was often only with a select group of students that he seemed to have a good rapport with. Further, the scaffolding and individual support strategies discussed one-on-one were rarely incorporated into whole-group instructional dialogue.

Teacher frustration with students also seemed to be a mitigating factor to their sensitivity practices. For example, after an incorrect response, Mr. Bell would repeat the same question over and over in an increasingly louder voice to emphasize his discontent and prompt students to think differently about their response. While this sometimes worked in soliciting a better answer from students, it also created confusion and tension that threatened students' perceived safety to be able to make mistakes freely. Students weren't always sure why they were being asked the same question over and over, and they were often unclear about what exactly Mr. Bell was trying to solicit from them. As the frustration and decibel level of his tone increased through repeated questioning, it conveyed his disbelief and surprise in the students' inability to perform the desired action, rendering feelings of incompetence, frustration, and shame among students. Over time, students resorted to silence during class discussions, acting out, or becoming combative. In turn, Mr. Bell and other personal-initiative teachers would blame students, describing these maladaptive behaviors and underperformance as laziness or lack of focus. Mr. Bell said "… and truth be told I get on her a lot because her skills are low. So I'm always trying to redirect her focus. Her skills are low and so she talks a lot because her focus is really low."

Low sensitivity seemed conducive to lower quality of feedback among these teachers. While they were persistent in some elements of quality of feedback, such as scaffolding or surface-level encouragement, they rarely engaged in feedback loops, employed persistent follow-up questions, or expanded on student responses. Further, scaffolding was almost always procedural and rarely conceptual. As a result, these teachers frequently missed opportunities to build on student thinking. For example, in Mr. Talleda's class, when students were solving a problem involving marbles and the distance they fell from the table to the floor, he never asked students why they thought the rate of change differed depending on the height of the table. Therefore, there was little opportunity to develop a conceptual understanding of the activity beyond the procedure for calculating rate of change.

Turbulent profiles in people-support and personal-initiative showed inconsistency in their enactment of sensitivity practices and quality of feedback. For example, Mrs. Brenda & Mrs. Bairos (people-support turbulent) often showed patterns of high teacher sensitivity (e.g., noticing students, checking-in) but engaged in lower forms of quality of feedback (e.g., checking for procedural correctness, but no push for conceptual understanding). Mr. Bell and Mr. Tobe (personal-initiative turbulent) also showed tensions in their sensitivity that resonated with formative experiences. Mr. Bell adopted what he self-described as a "tough love" approach. His care was often demonstrated through severity, rather than warmth for his students. He rationalized this through reflecting on his own experiences as a student, where he described himself as gifted mathematically but also "very lazy." While he acknowledged his own lack of effort as a student, he also resented his teachers for not being tough enough with him and letting him disengage academically. This resentment played out in interactions with his own students.

> I told him [*a student*] I had to go to summer school twice in my high school career because I was immature and playing around messing up like he was. And I said the same thing that is happening with you happened to me. How people [*teachers*] were just letting you get over and it builds a crutch, but with me I took it into adulthood and I had to learn how to stop getting over as a crutch so that's why I stay hard on all my students so they don't learn that crutch of getting over... sometimes I may yell at students and I have to reflect on it and I'll come back and apologize or if I push them too hard. You know, I got to come back and help them understand why I am pushing them.

This illustration clearly demonstrates how teachers' formative learning experiences not only inform their identity, but also play a role in their classroom practice, particularly care practices that are effective in supporting the motivation and growth of disenfranchised students.

Student Outcomes and Mediation Analysis. Thus far, I have presented evidence illustrating the connections between teachers' formative mathematical experiences, their teacher role identity and beliefs, and their enactment of classroom care practices. In this section, I examine whether teachers' formative experiences and classroom care practices predicted students' sense of belonging and achievement in mathematics. Specifically I assessed whether teachers' classroom care practices mediated the association between their articulated formative experiences and their students mathematical outcomes.

Initial correlations (Table 2) revealed teacher formative profiles (people-support vs. personal initiative) showed strong positive correlations with classroom care practices, teacher sensitivity (r=.61) and quality of feedback (r=.56), in favor of people-support teachers. There was no significant relation between the formative profiles and student outcomes. However, the classroom care practices showed small-to-moderate correlations with student belonging and mathematics achievement. A multivariate analysis of variance (MANOVA) observed differences between people-support versus personal-initiative teachers on their classroom care practices as well as student belonging and mathematics achievement. This analysis controlled for students' age, attendance, and baseline belonging measured in the fall. The multivariate result was significant for the teacher profiles, (F (4, 228) = 37.49, p < .001; Wilk's Λ = 0.60, partial η^2 = .40), indicating overall differences on the four dependent outcomes in favor of people-support teachers. The univariate F tests showed significantly higher teacher sensitivity (F (1, 236) = 91.99; p < .001; partial η^2 = .29), quality of feedback (F (1, 236) = 107.87; p < .001; partial η^2 = .32), and student mathematics achievement (F (1, 236) = 17.45; p < .001; partial η^2 = .07) for the classrooms of people-support teachers compared to classrooms of personal-initiative teachers.

Finally, to test for mediation, a structural equation model (Figure 2) was constructed with the teacher profiles as independent variable, student belonging and achievement as dependent outcomes, and classroom care practices (teacher sensitivity and quality of feedback) as the latent mediator. The final model showed sufficient fit to the data (χ^2= 164.93 df = 69, p = .001; CFI = .93, RMSEA = .06 [90% CI: .05, .09], SRMR = .06. Classroom care practices completely mediated the relation between the formative profiles and students' sense of belonging in mathematics (indirect effect: β= .15, p=.01 [95%CI .04, .26], as well as their mathematics achievement (indirect effect: β= .18, p=.00 [95%CI .08, .28]) controlling for baseline belonging and attendance.

Next, a multilevel SEM model was constructed to model the profiles and classroom care practices at the classroom level. Unfortunately, multilevel modeling applied to this same model failed to converge properly due to the number of parameters in the model exceeding the number of clusters (i.e., classrooms, n=21). In other words, the model did not have enough power (i.e., available classrooms) to test a model as complex as the one I proposed (i.e., number of parameters). Ludtke and his colleagues (2008) suggest well over 50 cluster units are needed to have sufficient power for multilevel structural equation modeling. Due to this, the model had to be simplified and partitioned. The first model examined the effect of the profiles (level 2) on belonging (observed & level 1), mediated by the classroom care practices (latent & level 2), controlling for baseline belonging (level 1). This model fit the data well with a non-significant chi-square (χ^2= 6.98 df = 3, *p* = .07; CFI = .97, RMSEA = .07, SRMR = .001. It also showed a significant positive indirect effect of the profiles on student belonging as mediated through teacher classroom care practices B=.34, *p*<.05 [95%CI .02, .66]. A second and similar model was run, simply replacing belonging with mathematics achievement as the dependent outcome and controlling for student attendance instead of baseline belonging. This model showed adequate fit, χ^2= 7.71 df = 3, *p* = .05; CFI = .91, RMSEA = .08, SRMR = .001; however, classroom care practices only marginally predicted mathematics achievement β= .37, *p*=.07 and the indirect effect of classroom care practices between the teacher profiles and students' achievement was not significant B=12.43 [95%CI -2.54, 27.42].

Discussion

This exploratory sequential mixed methods study sought to understand how urban mathematics teachers incorporated their formative experiences as mathematics students into their teacher identity, and how this related to their classroom care practices and their students' mathematical outcomes. Analysis of twelve teachers' interviews highlighted central themes, such as a set of beliefs that revolved around perseverance through mathematical problem solving. Importantly, however, teachers differed on their perceptions concerning the central processes that undergirded their ability to persevere through math difficulties, with some teachers emphasizing the people-support of key allies while others emphasized their own personal-initiative. The analysis underscored how teachers who emphasized formative experiences of people-support were also likely to hold the purpose of serving their students as allies through goals of creating supportive caring relationships. These teachers were also likely to hold ontological and epistemological beliefs that included critical consciousness of the sociopolitical and hegemonic factors that work against urban Black and Latino youth in education. In comparison, teachers who emphasized their own personal-initiative in persevering through mathematical challenges as a student were not as intentional in their care practice and tended to manifest ontological beliefs that focused on the students' attention, effort, and motivation as central catalysts in their mathematical difficulties.

The analysis of the interviews was corroborated and elaborated on by the classroom observations, showing that teachers whose role identity emphasized people-support also exhibited greater sensitivity to students, and provided higher-quality instructional feedback. In fact, these classroom care practices mediated the link between teachers' formative experiences and students' sense of belonging and mathematics achievement. The students of people-support teachers were more likely to report higher belonging in their mathematics class and score higher on their state standardized mathematics assessment compared to students of teachers whose role identity included beliefs that mathematical success is primarily based on personal-initiative.

Through this study, my intention was not to pit the people-support and personal-initiative perspectives against one another. Both personal persistence and support from others are essential to success in mathematics. However, when considering the beliefs and practices of teachers, the current data illustrates that predominantly focusing on personal-initiative was less likely to translate into teacher practices that were associated with better student outcomes in mathematics.

Some may associate a personal-initiative mindset with holding students accountable to take responsibility for their own learning. However, the present data suggests people-support teachers were not permissive in this regard, but demonstrated rigorous content-related expectations coupled with high support (i.e., warm demander, Kleinfield, 1975; Ware, 2006) that was ultimately associated with a greater sense of student belonging and mathematics achievement, particularly for students who are underserved and many have written off. This evidence suggests the importance of personal-initiative for student success was not lost on people-support teachers; however, they were also acutely aware of the importance of active and attentive support for their role. Thus, high expectations and standards were not weaponized against underserved students; rather, they were used to support them.

Admittedly, the role of teacher beliefs on student experiences is not novel. However, hardly any studies have empirically illustrated connections from teacher experiences to teacher beliefs, to classroom practice, to student outcomes. In fact, many studies have assessed teacher's beliefs and knowledge only, through interviews, questionnaires, focus groups, or reflective diaries. Little work has integrated multiple methods to triangulate the validity and intergenerational predictive power of teacher experiences. Such work is imperative, particularly within culturally-focused and social justice research (Sleeter, 2011).

Limitations

Despite the value of integrating multiple methodologies, this study is ultimately grounded in individuals' recollection of distal experiences, which is subject to bias. Recollection and interpretation of the past can be influenced by current events or the individual's conception of their present identity. Thus, it is difficult to ascertain the integrity of the teachers' formative experiences and whether teachers selectively chose or manipulated former experiences to match their current self-schema, perhaps even unconsciously. While this a methodological limitation of the present research, this lack of certainty as to whether teachers' experiences actually happened the way they described or if they were altered by current beliefs may be encouraging for intervention and teacher education. The latter may suggest a pliability of teachers' perceptions to uncover counter narratives or alternative interpretations of their experiences that may be more productive for their current teacher role, especially in light of the present findings that show empathetic care practices to predict important student outcomes.

While race, grade level, or years of teaching experience, did not seem to align with one of the profiles more than the other did, gender may have been a factor in teachers' recollection of how they framed their experiences or their classroom care practices. Given the small sample of teachers, this is difficult to ascertain. Only one man was represented among the six people support teachers and no women were represented among the four personal initiative teachers. Carol Gilligan's 'ethic of care' (1982) was originally developed as a moral virtue in response to more male dominated perspectives of morality as 'justice' and her ideas have been the bedrock of feminist ethics and theory ever since. Her writing also suggests women tend to emphasize empathy over justice, which recent neurobiological work mostly corroborates (Christov-Moore et al., 2014). Future research needs to assess how gender relates to teachers' classroom decision-making, their care practices and student outcomes in mathematics specifically.

Implications for Teacher Education

Given the nature and meaning of the current findings, it is clear that too often our pre-service teacher programs fail to acknowledge the lifetime of experiences teachers have that undergird how they believe learning and motivation happens, their role as teachers, and their perceptions about historically oppressed people and communities. Previous research highlights how understanding teachers' prior experiences (Wager & Foote, 2013; Wager, 2014) or previous exposure to notions of social justice work (Bartell, 2011) can provide insight into how teachers might take on equitable mathematics pedagogy. When considering how deeply ensconced teachers' educational values may be, reform-pedagogy teacher educators should not expect teachers to simply reconstruct their belief systems or purge their old values that have been in development for a lifetime. Such an expectation would contradict much of what we know about teacher conceptual change (Patrick & Pintrich, 2001). Teachers, like children, are likely to interpret new perspectives through the filter of their previous experiences versus deconstructing their old worldview to build another based on the new information (Sinatra, 2005). In instances where the new perspective is jarring to the old worldview, that information may be discarded as irrelevant and create tension or stress that may take considerable time, discussion, and novel experience to resolve (Kaplan & Garner, 2017).

Considering this, some poor approaches teacher educators can take in response to the individual's beliefs is offense (which usually shuts down discussion rather than encourages it), disregard (through countless subtle and explicit ways), or underestimating the amount of time it may take for beliefs to change (a semester or a single multicultural course). Rather, teacher educators have to be intentional about figuring out ways to partner with student teachers to process new and potentially discrepant information in ways that resonate with their existing worldview. In fact, teacher educators can implement empathetic care practices (Authors, Blinded), such as employing emotional consciousness to understand and manage the individual's frustration, recognizing and affirming the individual's identity, partnering with the individual through discussion of shared experiences, and pressing for content-based metacognition.

Teacher educators can use reflective writing to begin the process of having student teachers discuss their formative experiences in education. Similar to the structure of the current study, teacher educators may encourage students to make connections between their experiences and the current beliefs about teaching, learning, and motivation. For in-service teachers, teacher educators may push them to think of examples from their classroom practices that underscore their values. These reflections and subsequent discussions can create fertile opportunities to interrogate teachers' beliefs for possible reinterpretation. Teachers, like all individuals, can often cherry pick a limited number of experiences to support their perspective, without thinking critically about counter examples or alternate interpretations. Thus, within the context of mentorship, higher education classrooms, or personal trusting relationships, teacher-educators can push teachers to critically reconsider their experiences and re-evaluate their practices.

The permutations project (Ball, 1998) is an exemplar of how teacher educators can facilitate authentic reflection and discussion around experiences and beliefs. Here, preservice elementary teachers were given a mathematical topic (i.e., permutations) that they were unlikely to have formally studied before, rendering them as true learners on the topic. They had to learn the topic, watch a teaching demonstration, and finally teach the topic to someone else; all the while taking close reflective notes on their thinking, assumptions, feelings, and strategies. Through these semester-long activities, students realized various personally-held misconceptions and assumptions that were unhealthy for their future lives as teachers. Incorporating such practices into teacher education programs can encourage pre-service teachers to make connections between their past experiences, their beliefs regarding learning and motivation, and their pedagogical practices, which should facilitate more responsive and caring instruction. Understanding the formative experiences of mathematics teachers is a powerful lever to understand our next generation of teachers and design curricula that acknowledge their belief systems while also encouraging their development toward equitable teaching practices.

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Table 1.

Summary of Teachers' Characteristics

Teacher	Race/Ethnicity & Gender Identification	Grade Levels Taught	Years of teaching	Formative Experience
Mrs. Evans	Black woman	Middle	16	People-Support
Mr. Espada	Latino man	Middle	5	People-Support
Mrs. Emmett	Jamaican immigrant, Black woman	High	9	People-Support
Mrs. Ellena	Italian American, White woman	High	2	People-Support
Mrs. Brenda	Black woman	Middle	16	People-Support (Turbulent)
Mrs. Bairos	Portuguese American, White woman	High	15	People-Support (Turbulent)
Mr. Talleda	Ecuadorian immigrant, Latino man	High	12	Personal Initiative
Mr. Todd	White man	High	8	Personal Initiative
Mr. Tobe	Japanese American man	Middle	2	Personal-initiative (Turbulent)
Mr. Bell	Black man	High	13	Personal-initiative (Turbulent)
Mrs. Badowski	Polish immigrant, White woman	High	3	NA
Ms. Talbot	White woman	Middle	3	NA

Table 2.

Bivariate Correlations and Descriptive Statistics

	M	SD	*n*	1	2	3	4	5	6	7	8
1. Teacher Formative Profiles	-	-	276	-	-.32**	.38**	-.04	.02	.06	.61**	.56**
2. Age in Months	156.92	19.58	329		-	-.29**	.09	-.13*	-.12*	-.13*	-.12*
3. School Days Attended	163.25	23.22	329			-	.45**	.02	.08	.33**	.08
4. Standardized Mathematics Ach	732.45	33.97	325				-	.25**	.21**	.27**	.05
5. Student Belonging (fall)	5.11	1.08	329					-	.62**	.11*	.13**
6. Student Belonging (spr)	4.87	1.08	327						-	.20**	.21**
7. Teacher Sensitivity (observed)	4.44	.81	329							-	.76**
8. Quality of Feedback (observed)	3.90	.76	329								-

* $p < .05$. **. $p < .01$.

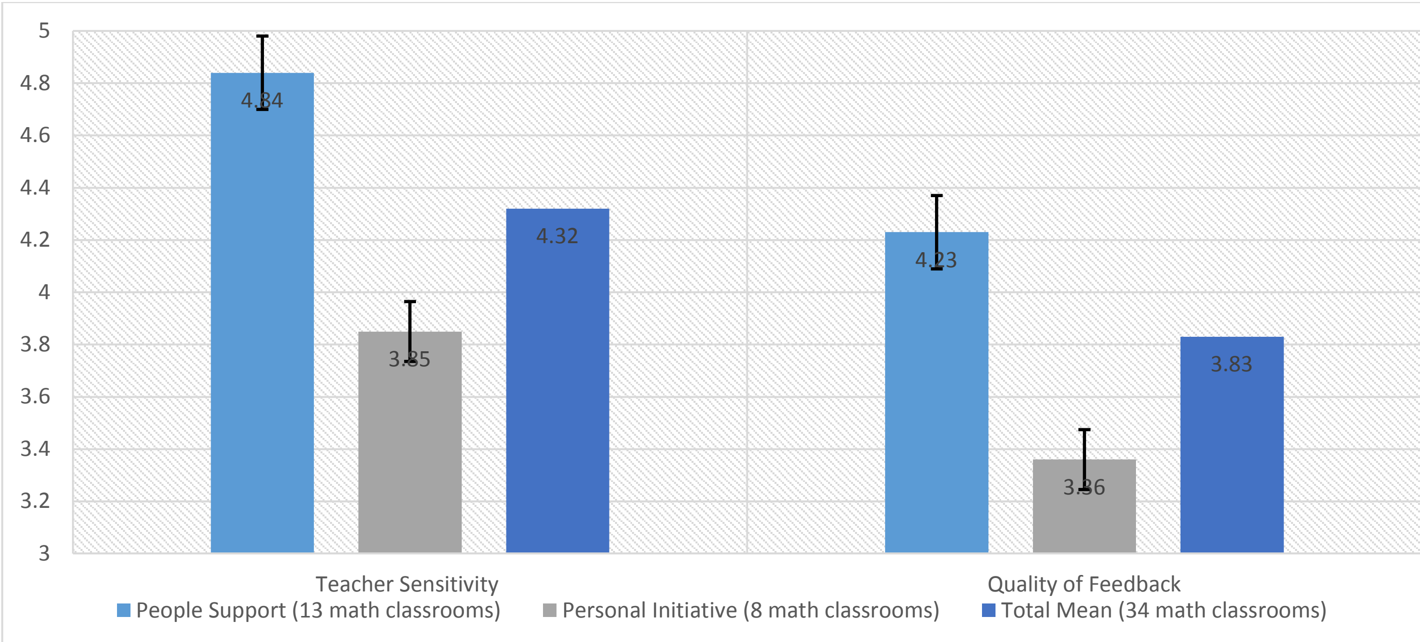

Figure 1: Means of Observed Classroom Practices by Teacher Formative Experience

Note: Observations are scaled from one (low) to seven (high); Error bars represent 95% confidence intervals

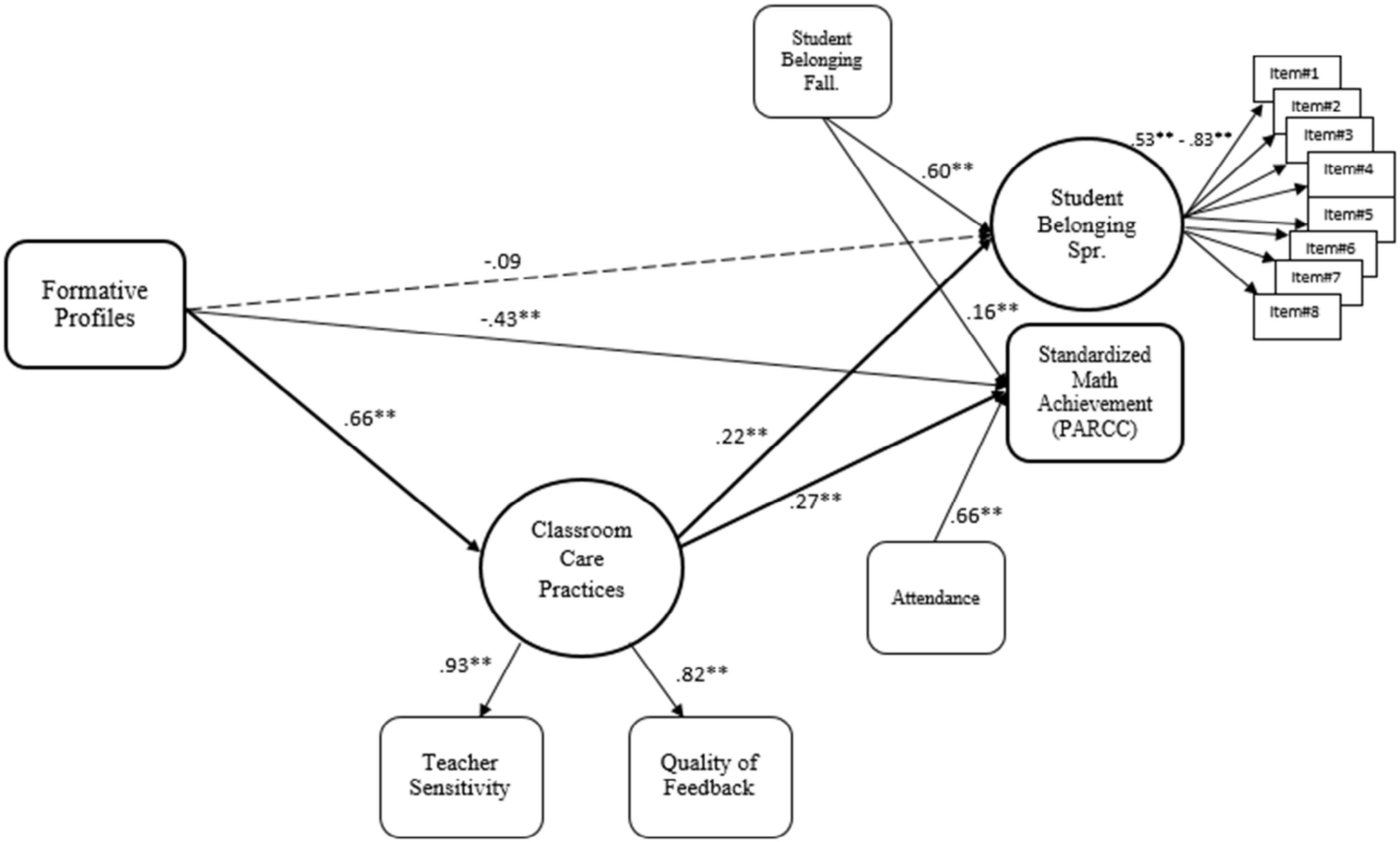

Figure 2:
Mediation Model of Teacher Formative Experiences on Student Belonging and Mathematics Achievement.
(χ^2= 164.93 df = 69, *p* = .001; CFI = .93, RMSEA = .06 [90% CI: .05, .09], SRMR = .06).
Standardized Indirect Effect: Formative Profiles → Classroom Care → Belonging β= .15, *p*=.01 [95%CI .04, .26]
Standardized Indirect Effect: Formative Profiles → Classroom Care → PARCC β= .18, *p*=.00 [95%CI .08, .28]
* *p* < .05. **. *p* < .01. Standardized coefficients