Detailing Relational Interactions in Urban Elementary Mathematics Classrooms

Dan Battey
Rutgers University

Rebecca A. Neal
Hamline University

Received: 22 February 2017 / Accepted: 26 June 2017

The lack of quality of instruction in urban mathematics classrooms in the United States has received much attention in the scholarly literature. Other classroom mechanisms such as relational interactions, however, have not received much attention of mathematics education researchers. Relational interactions go above and beyond content instruction to pass on messages about who is mathematically able, whose mathematical contributions are valid, and whose cultural practices are legitimised. Examining lessons across seven classrooms, this exploratory study documented five dimensions of relational interactions: addressing behaviour, framing mathematics ability, acknowledging student contributions, attending to language and culture, and setting the emotional tone. The frequency of the interactions differed significantly across the classrooms, as did the quality. Addressing behaviour and acknowledging student contributions were commonly occurring dimensions though the first skewed negative and the latter positive. The article details the varied ways in which the seven teachers interacted with their African American and Latino students during mathematics instruction.

Keywords · urban education · mathematics instruction · relational interactions · equity

Introduction

Research conducted in a range of contexts has shown that the quality of mathematics instruction available to indigenous or oppressed groups is of low quality or deficit-based (Ferguson, Gorinski, Wendt-Samu, & Mara, 2008; Howard & Perry, 2005; Ladson-Billings, 1997; Lubienski, 2002; Warren, Cooper, & Baturo, 2010). Whether instruction is with Pasifika students, Australian indigenous students, or the African American and Latinx students, as in this study that lived around the poverty line, mathematics teachers are often seen teaching mathematics through disconnecting procedures from students' thinking, focusing on one correct strategy, and assessing students based on following steps rather than explanations. Despite this, approaches that challenge these limited forms of instruction for marginalised student populations are being explicated more and more in the literature.

For example, Waddell (2010) discusses the benefits of reform-oriented instructional practices. In her review, she found that multiple studies showed schools that adopted reform curricula and implemented reform-oriented or inquiry-based instructional practices better-served urban African American students in the US in mathematics. Boaler's work also shows that reform-based mathematics teaching provided students with more access to mathematics

(Boaler, 2006; Boaler & Staples, 2008). In her research, Boaler documents how open-ended problems, problem-solving approaches, space for student discussions of mathematics, and heterogeneous ability groupings, serves students well in developing a deeper understanding of the mathematics. While this work suggests that higher quality mathematics instruction, here referred to as content instruction, benefits students, it does not appear to be widespread enough nor may it be enough on its own when teaching mathematics to serve marginalised student populations. This is because instruction, framed narrowly on content through problem solving, explanation, and discussion does not take into account the teacher-student relationships that are central to student success in mathematics.

Teacher-student relationships have been shown to be a critical component of instruction (Anthony & Walshaw, 2007; Eccles, 2004; Jerome, Hamre, & Pianta, 2009; Murray, Waas, & Murray, 2008). While good mathematics instruction is requisite, it might not manifest itself in learning unless teachers develop meaningful relationships with marginalised students. In the US context, teachers' and students' ratings of their closeness and conflict are very accurate when students are white. However, their ratings are inaccurate when the students are African American or Latinx (Jerome, Hamre, & Pianta, 2009; Murray, Waas, & Murray, 2008). Although the studies did not parse the teaching populations by race, the predominant portion of teachers in both studies were white females. And in both studies, teachers perceived these relationships as more conflictual than the students did. Additionally, Pianta and Stuhlman (2004) found that teacher rated conflict is a better predictor of mathematics achievement than closeness. This work raises the possibility that quality content instruction may not be enough if teachers are building uncaring relationships with students. In fact, when teachers develop conflictual relationships with Latinx and African American students, these interactions can result in students' disengagement, misbehaviour, or dropping out (Feagin, Vera, & Imani, 2001; Solórzano, Allen & Carroll, 2002).

In particular, a number of international scholars have noted the need to attend to caring dimensions of instruction in order to attain more socially just outcomes in mathematics classrooms (Averill, 2012a, 2012b; Bartell, 2011; Boylan, 2009; Povey, 2003; Walshaw & Anthony, 2008). Specifically, effective teacher-student relationships have been shown to be critical in the learning of Māori and Pacific Nations students (Averill, 2012b; Bishop, Berryman, Tiakiwai, & Richardson, 2003; Fletcher et al., 2009; Hill & Hawk, 2000). However, they have not received much attention as a mechanism in the mathematics learning of African American and Latinx students in the US context. Here we use the concept of *relational interactions* (RIs) as a lens to examine the teacher-student relationships in the classrooms under study. The authors define RIs as a communicative action involving moment-to-moment interaction between teachers and students, occurring through verbal and nonverbal behaviour that conveys meaning (Battey, 2013). By looking at RIs as they play out in mathematics, we examine the varied ways in which they are enacted in classrooms. This mixed-methods study examined 7 fourth and fifth grade classrooms in one urban school to better understand RIs with Latinx and African American students. Our study aims to gain a more detailed understanding of the ways in which urban mathematics teachers relationally constrain and support students' mathematics learning with the goal of using this understanding to develop richer learning opportunities for prospective and practicing teachers. The two research questions this study addressed were: 1) What are the types of RIs within urban elementary mathematics classrooms? and 2) What are the various ways in which RIs are enacted across these classrooms?

Teacher-Student Relationships in the Mathematics Classroom

The research literature that follows has approached the study of teacher-student relationships in mathematics classrooms in a number of different ways. While some studies focus on how teachers acknowledge student contributions, provide emotional support, and highlight student competence, others focus on positioning students' linguistic and cultural backgrounds as resources. We briefly review this literature below.

A number of scholars have focused on developing caring relationships within mathematics education (Averill, 2012a, 2012b; Bartell, 2011; Boylan, 2009; Hackenberg, 2010; Povey, 2003; Walshaw & Anthony, 2008). Hackenberg (2010) studied how teachers can form caring relationships with students, both with respect to their mathematical ideas and their emotions during learning. In working with four students, she shows how teachers can build caring relations through mathematical support. Bartell (2011) conceptualises "caring with awareness", which explicitly addresses cultural and racial aspects of relationships. In theorising caring with awareness, Bartell contends that teachers of Latinx and African American youth must take on student perspectives, and in doing so, explicitly challenge stereotypes about who is mathematically competent. Averill (2012a) examined the teaching behaviours that established caring relationships within multiethnic classrooms including Māori and Pacific peoples. In her study, she looked at teacher practices in secondary schools with the goal of developing culturally responsive mathematics teaching. Averill highlights caring mathematics teaching practices such as incorporating inclusive language, providing encouragement, making space for sharing personal identities and experiences, and being explicit about expectations as ways to build from cultural capital of indigenous and other marginalised student populations. Averill's work represents the broadest examination of teacher-student relationships within mathematics education in conceptualising physical, social, spiritual, and cognitive and emotional dimensions of classrooms. Across all of this work on caring, the research shows teachers caring for student contributions, the emotional space of classrooms, as well as connecting to student's culture.

Another line of work focuses on the ways in which students' mathematical contributions are valued. Boaler (2006) discusses highlighting the intellectual value of student contributions through explicit statements, questioning, or asking students to share their mathematical thinking. In doing so, students are framed as mathematically competent, disrupting the low status and fixed notions of ability that are all too common in mathematics. Empson's (2003) research also speaks to the importance in framing students' contributions as having value. She found that for the lowest achieving mathematics learners, positive interactions with the teachers served to enhance their mathematical identity and performance. Both of these researchers highlight the importance of acknowledging the mathematical ideas of learners, but also that this frames students as competent.

While Boaler and Empson's work does not draw heavily on the concept of culture, other research places culture as central. For example, Gorgorió and de Abreu use the notion of social representations to understand teacher student interactions in mathematics classrooms (Gorgorió & de Abreu, 2009). In this research, they highlight the way teachers dismiss mathematical thinking or misinterpret cultural representations within mathematics. Similar to Bartell's work, this work on social representations highlights cultural aspects of mathematics classrooms that impact student engagement. In contrast to the work studying cultural misinterpretations, Civil and colleague's work focuses on classrooms where teachers value the cultural knowledge of parents and students (Civil, 2007; Gonzalez, Andrade, Civil, & Moll, 2001). Hunter and colleagues work illustrates the ways in which teachers can build on the cultural values of Pasifika students such as reciprocity, communalism, and collectivity (Hunter, 2008; Hunter & Anthony, 2011). Even as teachers were responsive to student's cultural values

however, questioning or challenging by peers were still difficult emotional experiences for students (Hunter & Anthony, 2011). In blurring the boundary between the school and home, teachers brought students' experiences into the mathematics and aligned instruction with students' cultural values. This research emphasises that the values, representations, and knowledge, which students bring to the classroom, are central to quality mathematics instruction.

The overlap between culture and language is complex, but both play a role in developing teacher-student relationships in mathematics. Setati and Adler (2000) highlight the overlap between culture and language in examining code-switching within mathematics classrooms. In their research, code-switching serves as both a tool to move between informal and formal talk as well as across mathematical discourses (Setati, 2008; Setati & Adler, 2000). Moschkovich (2007) also highlights the importance of language in bridging relationships with students and how perspectives on language can serve to construct mathematical competence. She stresses the importance of providing bilingual students access to mathematical discourse, defined more broadly than simply vocabulary (Moschkovich, 2007). Both strands of work demonstrate the complexity in language practices in mathematics, but also that the practices are cultural in nature.

Work on positioning cuts across dimensions of teacher-student relationships. For example, Dominguez, LópezLeiva, and Khisty (2014) examine an after school setting focusing on student-to-student positioning around social and mathematical engagement. The study looks at how relations produce engagement between students, including how students connected language and home practices to the mathematics, collaboratively worked on the mathematics, and made emotional connections to the work. Wood (2013) examines the positioning of one student in a whole class context. She specifically focuses on both productive and unproductive ways in which students are positioned with respect to competence. Finally, Turner, Dominguez, Maldonado, and Empson (2013) also focus on whole class discussion, within an after school program. Similar to Dominguez et al., they attend to successful positioning. Turner et al. (2013) emphasise relational dimensions of framing competence and contributions in classrooms in productive ways, as well as positioning students' language and culture as a resource. This focus allows the authors to name specific productive teacher moves to support mathematics identity development.

The work on positioning theory captures a broader range of these dimensions including elements related to emotions, language, culture, and competence. However, even considering this, most of the studies discussed here go in more depth within one classroom or after school setting rather than looking across classrooms. In the present study, we are focused on interactions both within and across classrooms, and therefore take a more general approach to documenting the types of RIs. While there are drawbacks to looking within and across classrooms for multiple dimensions of relationships in terms of losing detail, this also allows us to look at classroom relationships that are both positive and negative, to compare relational dynamics across classrooms, and to look at particular relational moves that impact learning.

Methods

To detail RIs, a sequential qualitative first mixed methods design was used (Creswell, 2003). Data collection was qualitative, but qualitative methods and descriptive statistics were integrated in the analysis of the data. Classroom video was captured to document the various dimensions of RIs that occurred in the elementary mathematics classrooms. This analysis responded to research question one. The interactions were then rated on intensity and

frequencies were calculated based on the dimension and number of RIs per instructional minute for each classroom. This more detailed analysis allowed for a fuller description of the range of RIs within each dimension in order to respond to research question two.

Teachers were videotaped in the last month of their school year. This allowed for relationships as well as instructional norms to have been established. All of the teachers taught the handshake problem in their classrooms:

> Twenty people are at a party. If each person is to shake everybody else's hand once, how many handshakes will take place at the party? How many handshakes will take place for 21 people? How does the number of handshakes grow every time someone new arrives at the party?

Therefore, the content of the lessons observed was held constant and the researchers were able to focus observations on the various subject matter and pedagogical decisions made by teachers based on their students and the nature of the mathematics they wanted students to learn.

Participants and Study Context

The seven classrooms in the study were located in a K-5 elementary school of 1300 students (85% Latinx, 15% African American) in an urban district in the southwest U.S. Over 50% of students were designated English Learners (ELs) and 86% received free or reduced lunch, a proxy for SES. On the fourth grade state mathematics test, only 16% of African American and 41% of Latinx students achieved proficient or higher (state average, 66%).

All seven classrooms were in 4th and 5th grade and consisted of approximately 30 students. The teachers averaged 4.7 years of teaching experience (see Table 1). Despite this, the teachers averaged only 1.9 years of experience teaching mathematics. This was due to one teacher having taught physical education (Mr. D) and another who taught typing previously (Ms. B). None of the teachers had been at the school for over 3 years. Racially, three teachers identified as African American (Ms. B, Mr. J, & Mr. G) while three teachers identified themselves as white (Mr. D, Ms. S, & Mr. T). One teacher (Mr. L) identified himself as Latinx.

Table 1: Teacher Information

	Teacher							Average
	Ms. B	Mr. J	Mr. D	Mr. L	Mr. G	Ms. S	Mr. T	
Grade	4th	5th	4th	5th	5th	4th	5th	
Years Teaching	4	1	20	2	1	3	2	4.7
Years Teaching Mathematics	2	1	3	1	1	3	2	1.9

In addition, we briefly want to give the reader a sense for the quality of instruction across the classrooms. Six of the seven teachers had students share strategies during the lesson (except for Ms. B). Additionally, five teachers had students model the handshakes within the lesson, either with the entire 20 people at the party or reduced it to 5 people so students could see the pattern (all but Mr. J and Mr. L). Finally, four teachers built the pattern by starting with smaller numbers and increasing until they got to twenty (all but Mr. D, Mr. G, and Mr. J). This allowed students to see the pattern and begin applying to higher numbers. While a number of teachers used these practices in their instruction, the quality of their use differed greatly. Moving from left to right in Table 1, the teachers exhibited more standards-based instruction. The variance in instructional quality across these classrooms provided a rich dataset to examine relation interactions across different classroom environments and quality of instruction.

Data Sources

The project collected data using two sources: classroom video and observational field notes. The video provided a way to analyse both RIs and instruction, while the field notes were supplemental in recording dialogue at a distance from the camera.

Video Data: video was collected approximately one month before the end of the year for each teacher on one lesson. The camera was positioned to capture the entire class, but followed teachers when they moved to talk to individuals or groups of students. The camera also focused to record board work when necessary. Lessons lasted between 30 and 90 minutes.

Field notes: during the lessons, the research team took field notes focused on teacher-student talk. In particular, every effort was made to capture the conversation verbatim as well as physical gestures and verbal emphases that were made. The purpose of the field notes was to supplement the video record and to record conversations that the video might not capture.

Analysis

Coding of relational episodes allowed the authors to respond to the types of RIs as well as the varied ways in which they were enacted across classrooms. In conceptualising RIs within mathematics, we relied on the previous literature cited as well as case studies that detailed five dimensions: addressing behaviour, framing mathematics ability, acknowledging student contributions, attending to culture and language, & setting the emotional tone (Battey, 2013; Neal & Battey, 2014). The one dimension not discussed previously in the literature, addressing behaviour, was added because the broader educational literature has found that African Americans and Latinxs receive more negative consequences for their behaviour (Ferguson, 2000; Neal, McCray, Webb-Johnson, & Bridgest, 2003). This research has found that African American and Latinx behaviour is rated by teachers more harshly, leads to higher referrals for special education, is attributed by teachers as lower achieving, and is thought of as more threatening. This raises concerns that students might receive extensive negative feedback for their behaviour, restricting their access to mathematics and therefore was included in the analysis.

Interactions were coded in Dedoose®, a video analysis software tool that allows for direct coding of video. We coded episodes rather than turns of talk. In this choice, we use Forman & Ansell's (2001) definition as an "entire exchange that occurred between a teacher and students" (p. 124). While their definition focuses on exchanges around a student strategy, we include interactions that focus on emotion, behaviour, and language as well. The focus on episodes allowed us to include both teacher and student talk within the codes.

RIs were coded in five layers. First, episodes were coded for including RIs—any teacher-student communicative interaction, not just teacher moves, that went beyond content instruction. The second layer identified the RI dimension described in Table 2. Episodes were not double coded for dimension, and the code captured the predominant message sent to students in the interaction. We also looked for episodes that did not fit within the dimensions.

Table 2: Relational Interactions: Definitions and Supporting Literature

Dimension	Definition	Supporting Literature
Addressing Behaviour	Includes responses to some form of student behaviour. Calling on a student would not be included unless there was some relational aspect.	Ferguson, 2000; Neal, McCray, Webb-Johnson, & Bridgest, 2003
Framing Ability	Includes comments that frame students' general capabilities to do mathematics. Instances must include broad comments rather than a specific assessment of a contribution.	Boaler, 2006; Turner, Dominguez, Maldonado, & Empson, 2013; Wood, 2013
Acknowledging Student Contributions	Includes a teacher's response when it values/devalues or praises/disparages the students' contribution. These are teacher responses to specific student ideas and work, rather than broader comments on ability.	Boaler, 2006; Dominguez, LópezLeiva, & Khisty, 2014; Empson, 2003; Hackenberg, 2010; Turner, Dominguez, Maldonado, & Empson, 2013; Wood, 2013
Attending to Language and Culture	Includes references to cultural or everyday situations, including embedding math problems within familiar situations. The same would be true for any negative references to students' culture or everyday lives. Includes shifts in language practices that use more informal or cultural forms of speech as well as body movement or positioning.	Averill, 2012a, 2012b; Bartell, 2011; Civil, 2007; Gonzalez, Andrade, Civil, & Moll, 2001; Gorgorió & de Abreu, 2009; Hunter, 2008; Hunter & Anthony, 2011; Jorgensen, Grootenboer, Niesche, & Lerman, 2010; Moschkovich, 2007; Setati, 2008; Setati & Adler, 2000; Turner, Dominguez, Maldonado, & Empson, 2013;
Setting the Emotional Tone	Includes teachers more generally stating expectations, preempting behaviour, or creating an emotional space for students. This is not a specific response to students as compared to addressing behaviour and acknowledging contributions.	Averill, 2012 MERJ; Boylan, 2009; Dominguez, LópezLeiva, & Khisty, 2014; Hackenberg, 2010; Hunter & Anthony, 2011; Povey, 2003

Third, we coded emphases. Emphases refer to both verbal and nonverbal communication that accentuated an interaction such as stressing one's voice or gesturing. Drawing on the emphasis, we next identified interactions as positive/negative based on the tone and type of recognition of student thinking or behaviour. We made decisions based on the student(s) that the teacher was interacting with. Therefore, a positive interaction around behaviour might be recognising model behaviour of one student, when another student is misbehaving. However, focusing on the positive behaviour does not send a direct message to the student misbehaving. Therefore, it is possible that indirect messages to students were not captured by the analysis, but it is also not clear whether students received these messages.

The fifth layer coded the intensity of the interaction (low-1, medium-2, high-3). We drew on the emphases codes to characterise the intensity. If an interaction did not contain any emphasis, it was coded low. If an interaction contained one or more emphases, we classified it as medium

or high depending on the extent of the emphasis. For instance, an episode with one form of emphasis in terms of vocal stress could be coded as high intensity if it was extreme (e.g. yelling). High intensity was reserved for particularly strong interactions, positive or negative.

Inter-rater reliability was 90% in identifying RIs, but the researchers came to agreement on 98% of episodes. Interactions without agreement were thrown out. Finally, we calculated the frequency of RIs by dividing the total number of interactions for each teacher by the time of instruction. We did this to provide a way of comparing classrooms.

Results

The results are first organised by RI dimension. Within each dimension, we start by giving an overview of the frequency of interactions and then use examples to both illustrate the dimension and describe the varied ways each dimension was enacted. The study found five dimensions of RIs. The four previous dimensions were confirmed through the analysis. However, a fifth dimension, setting the emotional tone, also emerged. Following the analysis by dimension, we briefly look across the classrooms to see how RIs differed in quantity and quality for each teacher.

Addressing Behaviour

Addressing behaviour was a common form of interaction that included directive moments, highlighting of positive examples, as well as punitive dealings with misbehaviour. Addressing behaviour accounted for 30% of interactions and was overwhelmingly negative (91%). No teacher demonstrated positive interactions that were of medium or high intensity. The positive interactions around behaviour consisted simply of noting positive student models, but these were infrequent. A positive example of an interaction involved Mr. L praising students for their compliant behaviour, "Some people are doing mathematics very quietly in front." This example of a low intensity positive interaction shows a teacher highlighting models of good behaviour, but using no emphasis. While this could be seen as a possibly negative interaction to students not in the front or not adhering to the classroom expectation to work quietly, since it did not show a focus on misbehaviour or direct admonishment of students, it was considered positive.

Negative interactions took one of two forms, directing student behaviour or a usually intense focus on misbehaviour involving vocal stress or physical gestures. We use Mr. L and Mr. T to highlight these practices below. Mr. L's instruction was fairly teacher led, but he still struggled with behaviour. In his 23 negative interactions, he repeatedly called out misbehaviour with an intense focus on 2 students, Andrew and Jeremy.

Andrew: We don't want to… [calling out]
Mr. L: Let me just talk about this, ok?
Andrew: I've got a pounding headache [Mr. L raises hand to stop position to quiet Andrew].

Mr. L: Andrew and Jenny, if you don't want to participate here, you just have to leave. Ok?
Andrew: I do want to participate!
Mr. L: Then quiet please [raises finger to lips to hush Andrew].

Unfortunately, these episodes did not end for Andrew. Within the 47-minute lesson, Andrew had seven such interactions with Mr L. They generally became more intense and Andrew turned away from the board entirely for almost 5 minutes. Interactions with Jeremy were similar.

Jeremy: Is that an n? [calling out]
Mr. L: That goes for you too, ok? One more time and you're *out* [points to student and points to the door]. You're not raising your hand. I didn't ask you to participate. Just listen [points to ear]. Can you hear me?
Jeremy: Yes (very quietly).
Mr. L: Did you hear me say teen or team?
Jeremy: Team (very quietly again).
Mr. L: Well then don't ask me those questions that you already know [stares at student for extended time and points].

Mr. L: [to Jeremy] I'm going to send you to someone else, you're not doing *nothing*. You're not raising your hand, you're not doing *nothing*.

Mr. L struggled with managing both students and repeatedly tried to control their participation. The interactions escalated to points where Mr. L raised his voice and became more physically demonstrative. Jeremy had 5 such interactions during the lesson. The two boys together accounted for over half of the negative behavioural interactions during the lesson.

Mr. T's treatment of behaviour was also consistently negative. However, his instructional practices were much more aligned with reform ideas than Mr. L.

Mr. T: *No pencils may be in your hand*. *You will be disqualified*, if you are working on the problem now [standing over a group of students].

Mr. T: If you *talk* while they're up there, there will be no *lunch recess* [arms crossed].

Mr. T struggled in managing students while others were sharing and during group work. In the first statement he pointed during each word that was italicised. In the second, he stood with arms firmly crossed staring intensely at a pair of students. There were 18 such interactions within 45 minutes, and in many of these, he presented an intimidating demeanour through physical gestures, posture, and vocal stress. Interestingly, his content instruction was very consistent with reform notions of engaging in problem solving, having students share their thinking, and pressing for complete explanations. However, he struggled in managing behaviour in a more open classroom format moving from group problem solving to students sharing their thinking with the whole class.

Framing Mathematics Ability

Framing mathematics ability occurred when teachers made comments about individual students or the whole class in terms of their ability to do mathematics. Framing mathematics ability accounted for 10% of interactions (63% positive) and therefore was much less common than addressing behaviour. Teachers made comments about individual students or as a class about their ability to do mathematics. While these interactions were infrequent, they were usually quite intense, both positively and negatively.

Negative examples showed teachers thinking that students couldn't complete simple addition or holding low expectations for students' mathematics capabilities. For example, Mr. D introduced the handshake problem to the class, he simplified it and said "The original problem said 20 but I cut it down, um I didn't want to make it too difficult." In this statement, we see that Mr. D demonstrated low expectations regarding students' ability to solve the problem. As another example, Ms. B walked around the room as students solved the handshake problem, "You're not doing your *math*. Put your hands *down*. Until you do your math, put your hands *down*. Until you do your math, put your hands *down*. Do your math and do your addition *cor-rect-ly*. You gotta multiply *and add*." Ms. B is not looking at specific student strategies, but

generally stating that students need to do the math, repeating herself, stressing her voice, and articulating specific words. The message across this interaction is that the students are not doing mathematics, do not understand, or cannot do the mathematics. Considering that these are fourth grade students, discussing doing addition correctly would be considered condescending.

A comparison example is when Mr. G disrupted notions of deficit thinking regarding his African American and Latinx students. For example, while standing next to a student, looking at her work, he noticed she had drawn a picture as a way to help solve the problem. Mr. G said directly to her, "Oh this is *deep*! The emperor and his new clothes, didn't know that." While still next to the student, he stated to the rest of the class, "You guys can't see this yet, only me and Sarah can see this. This is deep. This is a *teacher-student* thing, only she and I can see it." With the student smiling and laughing at her desk, Mr. G holds up her work so others can see it and says, "She got 380," then displays a "thumbs up" physical gesture indicating his approval of her strategy. Students can be heard giggling and laughing in the background during this time. While this is going on in the classroom, students briefly stopped working to pay close attention to Mr. G's more informal language and social exchange with Sarah that repeatedly highlights her mathematical contribution as deep. Ms. S also affirmed individual students' abilities. After Selena shared a strategy, she noted, "Way to go *Selena*, good thinking. *Excellent*, very good," and one minute later "Ok, very good. Oh Selena, you're *awesome*." This praise for Selena's thinking became more generalised as the interaction went on, ending with Selena being "awesome". While some of these moments may have been small, they run counter, even if implicitly, with broader racial stereotypes, which is notable in classrooms that are demographically African American and Latinx.

Acknowledging Student Contributions

Acknowledging student contributions was the most common dimension of RI across teachers. This dimension accounted for 50% of interactions (63% positive). In acknowledging student contributions, teachers responded in varying ways to specific student's ideas and strategies. As one example, Mr. D defended and reinforced a student's thinking in front of the class when he said, "No, no he didn't do it *wrong*. He's *experimenting*." It was typical for teachers to comment on students' reasoning in various ways. For instance, Mr. T interacts with a group of students below while scaffolding the mathematics through questioning.

Edwin:	We multiplied by two.
Mr. T:	So why did you multiple 20 by 2?
Eva:	Because there are two people for each handshake.
Mr. T:	Ok, because there's two people who need to shake?
Student group:	Yes.
Mr. T:	*Interesting, interesting*. That's a good thought. Um, that's part of the problem. I want you to think about this. There are how many people at the party?
Student group:	20.
Mr. T:	If one person, James, shakes hands with everybody, how many hands did he shake?
Edwin:	19.
Mr. T:	19. Ok, now it's Eva's turn to shake hands.

In this episode, Mr. T asks the group to explain their incorrect strategy and acknowledges their contributions positively by repeating and vocally stressing "Interesting" and saying, "good thought". This episode shows him recognising the value in the thinking students' had already

done and then attempting to use that thinking to extend their strategy to a correct one. The scaffolding in conjunction with the positive acknowledgement of student contributions was typical for both Mr. T and Ms. S, both of whom enacted instruction more consistent with reform mathematics. However, the other teachers generally reacted positively to student thinking without providing the same instructional support.

Negative interactions usually disparaged student contributions. While Ms. B did recognise some student thinking positively, it was usually followed by telling those students that they needed to stop using their strategy and start using procedures successful students used. After posing the problem Ms. B called five students to the board to model the problem.

Ms. B: I want you to shake each other's hands [students start shaking each other's hands randomly].
Ms. B: No, *line up*. You [points to Angela] shake all of their hands [Angela shakes the hands of the other four students].
Ms. B: Now, how many hands did you shake?
Angela: 4?
Ms. B: Good. Write that on the board. Now, you [Avery] shake the other's hands [Avery shakes the other four students' hands, including Angela's].
Ms. B: *No*, you already *shook* her hand. Do it *again* [Avery shakes three other's hands and skips Angela].
Ms. B: How many hands did you shake?
Avery: 4?
Ms. B: *Wrong*. You shook *three*. Write a 3 on the board. Next.

Although Ms. B began the lesson by having students act out the problem, she directed the steps needed to model the handshakes. Expectations for how to model the problem were not clear as each student randomly shook each other's hands. She stopped them and lined them up, but Avery re-shook Angela's hand and was reprimanded and then directed to write a three on the board. In general, repeating each of Ms. B's steps was the only acceptable strategy for students. Another negative interaction occurred when Mr. L continued to engage with Jeremy from the earlier behavioural interactions. He was walking around the classroom examining student work until he stops at Jeremy's desk. "You haven't written *nothing*. You haven't done nothing. You haven't participated. You're not doing *nothing*." Repetition was used here as a form of emphasis. While consistent with the earlier interactions around behaviour, this interaction was focused on Jeremy's mathematical contributions to the class and on his paper, rather than addressing the way in which he called out. Across these examples, teachers complimented students' contributions more often, but disparaged contributions more intensely.

Attending to Culture and Language

Attending to students' culture and language occurred when teachers used examples or generated problems around student interests as well as the ways in which they dealt with Spanish or students' informal language. There were limited instances of teachers attending to students' culture and language in only 5% of interactions (78% positive). There were only two negative interactions, both around language use. Mr. L limited a student's opportunity to share their mathematical thinking in the language of their choice. When a student volunteered their strategy and asked for them to share, he interrupted them by saying "No. Say it in English." While a low intensity interaction because it did not contain any form of emphasis, it did restrict the ways of participating in the mathematics and therefore can be perceived extremely negatively by students. Ms. S engaged in a negatively charged incident when she corrected an African American student's speech. During class, David explained a story using African

American Vernacular English about how he thought a cashier overcharged him for his purchase. He articulated a mathematically sound argument for how he was overcharged, but instead of acknowledging the student's mathematical reasoning, Ms. S interrupted him and indicated his verb-noun agreement was wrong and then stated what he should have done in the story. Ms. S failed to address the student's mathematical contribution, but instead critiqued his language use and social behaviour resulting in invalidating his language and behavioural practices.

Positive ways of attending to language and culture included attending to informal language practices and connecting mathematics to student experiences. Mr. L and Ms. S used everyday contexts students were familiar with such as going to the community pool. Below, Mr. L used the world cup as a comparable connection with the handshake problem.

Mr. L: Ok, let me talk a little about the World Cup.
Students: Ooh, the World Cup!
Student: Mmm!
Mr. L: One of the groups is group A.
Students: World cup! World cup! World cup!
Mr. L: Let me just talk about this, ok?
Mr. L: [He writes down four teams] How many teams?

After raising the context of the problem, students responded excitedly, including chanting "World cup". Students were talking about the world cup as they came back from lunch and this context built on many students' interests. Mr. L then set up the problem as four teams and asked how many games would be played in group A. The context of the problem was a good analogy to the handshake problem as the first team in the group plays 3 games, the second two additional games and so on. However, instructionally Mr. L continued by proceduralising the connection to the handshake problem, "Like any problem or word problem, what happens in the second problem? Don't you do the same thing, but you have to change the name, or the amount, place or the thing? We were talking about soccer, but now we're going to do shaking." This instance shows how a productive connection to culture can result in limited mathematical discourse and subsequently lower cognitive demand.

In a very different way, Mr. G opened up multiple ways of being in the classroom through movement, speech, and informality that are typically not observed in mathematics classrooms. He strutted around the classroom swinging his arms from side to side, upbeat, displaying high levels of enthusiasm during the lesson. In this sense, Mr. G's personal movement style opened up non-traditional ways of being in the classroom. A great illustration of this is at the end of the class, after the students succeeded in solving the mathematics problem. Mr. G engaged in a type of "victory dance", clapped his hands, and said rhythmically, "Give yourselves a *hand*, *yeah*! *Alright*! You guys are the *best*, not like the *rest*!" The class applauded, he pointed his fingers and extended his arms outward, walked in a celebratory manner, waived both his hands high in the air, smiled, looked at the class, and said, "Alright, alright, *alright*!" In addition to the excitement in seeing students generate new strategies, his physical movement relate to work from Cole & Boykin (2008). They assert that the physical movement styles embedded within a traditionally structured classroom can be restrictive for some students. For students from non-dominant groups, expressive movements can be "part of their everyday learning and communicative behaviour" (Cole & Boykin 2008, p. 333). Cole and Boykin (2008) contend that an Afro-cultural meaning system exists that connects music, verve, communalism, affect, rhythm, kinaesthetic movement, and gestures. We are not suggesting that Mr. G's expressions were about *students'* cultural expressions or ways of being, but simply noting his own style of teaching displayed movement patterns and informal ways of language use that are not typical in mathematics classrooms. He was the only teacher to bring this way of being into the mathematics classroom.

Setting the Emotional Tone

Setting the emotional tone occurred when teachers set up a particular environment that conveyed what it means to emotionally and behaviourally be in the mathematics classroom. Setting the emotional tone of the classroom accounted for 5% of interactions across classrooms (60% positive). Setting the tone sometimes captured teachers pre-empting student misbehaviour in a way that reveals negative expectations, but unlike prior dimensions listed here, is not specific to a particular student's behaviour, contribution, or language use. This is consistent with Stiff and Harvey's (1988) claim that mathematics teachers often hold negative views of students of colour that lead to pre-emptively controlling students. However, teachers could also set up a safe space or support students in persevering with the mathematics. In this way, it is aligned with work on caring relationships discussed earlier. This can entail providing emotional support, taking on student perspectives, or explicitly challenging negative stereotypes.

All of the negative examples came from Ms. S and were focused on pre-empting misbehaviour. Here, Ms. S set up an opportunity for 20 students to model the handshakes, "Now, if we can't behave and follow directions at this party, we're going to have to go back to our desks and do it individually." While no student had misbehaved yet, this low intensity example is focused on the possibility of misbehaviour. Another example also shows Ms. S displaying low expectations of student behaviour. At the beginning of the lesson she stated, "If I see you are arguing and this and that, I may have to step in." Here, she is establishing an expectation that students might engage in misbehaviour.

Positive examples of setting the emotional tone show teachers sending messages about who students are and the type of classroom environment they were developing. A higher intensity positive example occurred in Mr. G's classroom during a whole class discussion.

> Is there anybody that doesn't understand this problem still? Don't be ashamed. You know you can't be ashamed in this class because I tell you all the time, there's a lot of stuff I don't understand in math, I'm going to make it one of my... It's one of my goals. If you're working on that too, it's ok.

While Mr. G said this, he smiled (positive emphasis) and moved around the room, inviting students to struggle (repetitive emphasis) with the mathematics alongside him. Another positive interaction, though of low intensity, is when students in Mr. J's class struggled to understand the handshake problem. He reassured students, "There's no right or wrong way to explain it. Just explain it however you feel comfortable."

Lastly, Mr. G affirmed that students were smart mathematically, while noting his own limitations. After a number of students had shared strategies for the problem, he noted his own mathematical difficulties, but assured students that they can still understand the mathematics.

> Now I told you this before, my mind does not think algebraically, and um if I looked at this, I would be thinking, what is a way that I could do this and get the same answer, do it quickly, and I would do this, so, for my mathematician over there, you would probably like this, [pointing to a strategy on the board that is more algebraic] you guys are sharp, really smart.

Erasing the board to create space to demonstrate another way to solve the problem, Mr. G continued, "If you are like me, and think math is not my cup of tea, but I want to be able to break this down and at the same time understand it, you might want to try this way. I thought this was nice." Then he began to explain how the handshake problem could be solved using an alternative method. In this interaction, he personalised struggles with mathematics, normalising them, and brought vulnerability to the mathematics classroom while still affirming mathematicians in the classroom and varied ways to think mathematically.

However, we do not want to oversimplify this interaction. While Mr. G values multiple ways of solving the problem, he equates algebraic thinking with being "smart". In trying to normalise struggles with mathematics, he communicated a limited notion of mathematical intelligence and further stated mathematics was not his cup of tea. This promotes a binary of math "smartness", which runs counter to the notion of promoting multiple mathematics intelligences (e.g. non-math versus math people; Featherstone et al., 2011). Therefore, in opening multiple ways of solving problems, Mr. G reproduces much of the status associated with the various strategies (concrete versus abstract). Thus, at times, the examples within setting the emotional tone, could communicate complex messages.

Enacting Relational Interaction Dimensions

Across the seven classrooms, teachers generated 188 RIs. Table 3 shows the interactions broken out by teacher, dimension, and positive/negative. The number in parentheses denotes the average intensity. Negative interactions, accounting for 55% of episodes, were of higher intensity. Most negative interactions were due to addressing behaviour. Two teachers had more positive interactions than negative (Mr. G and Mr. J). In terms of frequency, RIs were identified at a rate of about one every two minutes. However, this ranged substantially from .31 to .75 per minute.

Table 3: Relational Interactions: Frequency and Intensity

Dimension	Teacher							All
	Ms. B	Mr. J	Mr. D	Mr. L	Mr. G	Ms. S	Mr. T	
Behaviour								
Positive	2(1.0)	0	0	2(1.0)	0	0	1(1.0)	5(1.0)
Negative	1(1.0)	0	3(2.7)	23(1.8)	0	6(1.7)	18(1.9)	51(1.9)
Ability								
Positive	0	0	0	2(1.0)	6(2.5)	2(2.5)	2(1.5)	12(2.1)
Negative	2(3.0)	0	2(2.0)	0	0	2(2.5)	1(2.0)	7(2.4)
Contributions								
Positive	5(1.6)	4(1.3)	6(2.0)	3(1.7)	8(2.1)	18(1.5)	11(1.2)	55(1.6)
Negative	11(2.5)	3(1.3)	3(2.3)	2(2.0)	0	19(2.2)	1(1.0)	39(2.2)
Culture								
Positive	0	0	0	1(2.0)	4(2.3)	2(1.0)	0	7(1.9)
Negative	0	0	0	1(1.0)	0	1(3.0)	0	2(2.0)
Tone								
Positive	0	3(1.0)	0	0	3(1.7)	0	0	6(1.3)
Negative	0	0	0	0	0	4(1.0)	0	4(1.0)
Total								
Positive	7(1.4)	7 (1.1)	6(2.0)	8(1.4)	21(2.2)	22(1.5)	14(1.2)	85(1.7)
Negative	14(2.6)	3 (1.3)	8(2.4)	26(1.8)	0	32(2.0)	20(1.9)	103(2.0)
Interactions/minute	0.43	0.31	0.44	0.71	0.75	0.55	0.74	0.56

In some ways the seven classrooms look quite different. Ms. B, Mr. J, and Mr. D show a limited number of interactions and possibly not surprisingly, these classrooms typically focused more on teacher taught procedures and independent practice. Therefore, there were simply fewer

interactions between teachers and students about students' mathematical ideas. However, even in these more traditional classrooms, differences in positive and negative interactions are evident. Likewise, in the three classrooms (Mr. G, Ms. S, and Mr. T) that focused more on student thinking, reasoning, and justification, teachers interacted more with students, but that did not necessarily mean students' contributions were viewed just as positively. Interestingly, the dimension of framing mathematics ability aligned with the positive or negative focus on student contributions, though less frequent, for all of the teachers.

Behaviour played a major role in the number of negative interactions, specifically for Mr. L and Mr. T, and to a lesser extent Ms. S. This focus on misbehaviour led to escalating interactions in terms of intensity as well as threats for ending instruction and/or removing students from the classroom for all three teachers. Meanwhile, we see almost no focus on behaviour for Mr. J and Mr. G, but instead see both teachers establishing positive expectations for behaviour in terms of setting the tone.

Finally, attending to culture and language was very infrequent in these classrooms. While interactions in this dimension were more positive than negative, it is surprising given that the majority of the student population spoke both Spanish and English. Also of note, only 3 of the seven teachers addressed issues of culture and language within the lessons. Therefore, we see classrooms looking similar and different in terms of both the quantity and quality of their RIs for the various dimensions.

Discussion and Limitations

Returning to the first research question, most of the types of RIs were discussed previously in the literature. Framing mathematics ability, acknowledging student contributions, attending to culture and language, and even setting the emotional tone were discussed in various forms by scholars in mathematics education. However, addressing behaviour was the only dimension not previously discussed in the mathematics education literature, though it has been discussed more broadly in education. It is interesting to note that this dimension of behaviour, along with acknowledging student contributions, were the most frequent dimensions across classrooms. There were examples for each dimension that show teachers interacting in both positive and negative ways, with certain dimensions skewing decidedly negative (specifically for behaviour) and others skewing more positive. Finally, in looking at frequencies and intensities, the analysis provides one way to differentiate the quality of relational elements of instruction for the classrooms. Interestingly, teachers interact with varying frequency and show more negative or positive focus around behaviour and contributions.

However, the results of this study should be considered cautiously for a few reasons. First, the research included seven teachers and certainly is not generalisable, though the method and the conceptual framework could be applied to other contexts. Therefore, the frequencies and intensity could be specific to the teachers in this study. Additionally, in the early stages of this work, we do not know how consistent these interactions are across the year, day, or even for different levels of schooling. It is possible that this was a good or bad day for some teachers rather than representative of their instruction. Finally, since this was not necessarily a typical problem for some of the teachers, it could impact the RIs if students are not used to the type of mathematics or if it impacted teachers' beliefs about the capabilities of students to solve the problem. Therefore, gathering more lessons would provide evidence about how much RIs vary within classrooms.

Despite these limitations, the study does provide some interesting results. In particular, we think there are implications for teacher education and professional development about how

mathematics educators support teachers around behavioural norms, framing students' competence, inclusion of culture, and supporting the emotional space of classrooms. The relational aspects of behaviour in particular were considerably more negative than positive, consistent with research that shows teachers overreact when addressing behaviours of African American and Latinx students from low SES backgrounds and place a strong emphasis on controlling behaviour (Ferguson, 2000: Monroe, 2005). Even when controlling for economic status, Gregory and Weinstein (2008) found that teachers interacted more negatively with African American and Latinx students, issuing high levels of office behavioural referrals.

While this may seem like a finding unrelated to mathematics teaching, the comparison between Mr. L and Mr. T in their struggles to manage behavioural expectations despite vastly different instructional norms does raise concerns. When teachers take on more reform-oriented practices, an often-overlooked issue is how we support teachers in communicating different behavioural expectations. This requires teachers to develop different strategies for substantively managing student behaviour during student sharing, group work, and leading mathematical discussions. If behavioural issues result in school discipline, as has been well documented in the literature (see Gregory, Skiba, & Noguera, 2010), and in turn removes a student from instruction, it will heavily impact access to mathematics. This research raises the need to monitor the changing behavioural norms in classrooms as teachers shift to more reform-oriented instructional norms.

The relationship between the dimensions acknowledging student contributions and framing mathematics ability is of particular note. While framing mathematics ability occurred less frequently, for the most part, the ratio of positive to negative interactions were similar to acknowledging student contributions for teachers. It is likely that as teachers acknowledge contributions in various ways, students are implicitly sent messages about their ability. We saw a few moments when teachers' explicitly noted students' abilities, but in being conscious of various stereotypes about the abilities of marginalised students in mathematics, it raises the need for teachers to more consciously challenge deficit narratives. Empson (2003), in particular, found that positive interactions with the teachers served to enhance the lowest achieving mathematics learners' mathematical identity and performance. Knowing this, it is important for teacher educators and professional developers to have explicit discussions about being intentional about the ways in which student contributions are handled and how teachers play a role in shaping students' views of their own mathematical competence.

In terms of culture and language, it was interesting that we did not see many interactions around these constructs. Maybe this is not surprising given projects that have engaged teachers in opportunities to build cultural connections into mathematics classrooms have had a limited impact specifically on the curriculum (Averill, 2012a, 2012b; Jorgensen, Grootenboer, Niesche, & Lerman, 2010). However, in this context, with just over 50% of students identified as ELs in the school, we would have hoped to at least see more use of students' home language in instruction or more informal uses of language that connected students to the mathematics register. Across the examples in this article, we see a very limited range of ways that language and culture impacted mathematics. Certainly these ways do not exhibit the complexity of teachers embedding culture into the classroom as found in Civil's work, nor the complex ways in which culture impacts communicative interactions in Averill's research, but they do provide windows of opportunities to open up conversations in professional development about how culture plays a role in instruction. Making teachers aware of students' language use can raise opportunities for opening up more cultural ways of being in the mathematics classroom (Neal & Battey, 2014). We see these openings in the research in terms of allowing students to reason mathematically in their language of choice, using student experiences as connections to formal mathematics, and bringing more fully realised cultural teacher selves into the classroom space.

Since Leder and Grootenboer (2005) raised the limited attention emotions have received in mathematics education research, select scholars have begun to understand mathematics classrooms as emotional spaces (Averill, 2012a; Boylan, 2009; Hackenberg, 2010; Hunter & Anthony, 2011; Povey, 2003). However, there is still much we do not know about the role of emotions in mathematics classrooms, especially to develop more equitable teacher practices. It is possible that in looking more intentionally across classrooms (as opposed to prior case studies by the authors), that the emotional space was more evident. For instance, being in Mr. G's classroom would seem to be a fundamentally different emotional experience than Ms. B's or Mr. L's. While this study was not longitudinal to investigate the long-term development or impact of these relationships on students, these emotional elements of instruction often go unmeasured in research. Despite this, the messages sent within the emotional space of the classroom often convey important ideas (Boylan, 2009; Povey, 2003). In this study, sometimes these interactions sent messages about the need to struggle through mathematics or affirmed multiple ways to practice mathematics. Other times these interactions sent messages about a teachers' focus on misbehaviour. In conjunction with framing mathematics ability, messages about who students are in relationship to teachers and the mathematics are being co-constructed within classrooms everyday. These dimensions of RIs seem to be ways in which teachers reproduce or challenge broad discourses about who can or cannot engage mathematically (Battey, Neal, Leyva, & Adams-Wiggins, 2016). Supporting prospective and practicing teachers in being reflective and intentional about the messages they send is critical in teacher education (Boylan, 2009), especially when teaching students that are already marginalised in broader society.

We noted in the methods that this dataset was particularly rich for this study because the quality of instruction varied greatly across teachers. Interestingly, we did not find many patterns related to the type of instruction for teachers. One of the lone patterns was that in classrooms that tended to be more reform-oriented, teachers not surprisingly interacted more with students. However, that did not mean that the interactions were more caring (see Mr. L and Mr. T) or that student thinking was framed more positively (see Ms. S and Mr. D). This makes some sense in that the type of content instruction does not determine the quality of relationships being developed in classrooms, but may challenge implicit notions in the literature that changing content instruction necessarily improves access for students. Instead, this speaks to the need to support all teachers in building caring relationships, whether instruction is inquiry oriented or not.

Conclusion

More than anything, we think the major contribution of this work is to provide a framework for both prospective and practicing teachers to attend to and reflect on relational dimensions of classrooms. The RI framework used in this paper can be a tool in professional development and teacher education to monitor interactions in field experiences, student internships, and classrooms around each dimension. In this way, teachers can be more attentive to hyper-focusing on misbehaviour for African American males for instance or ways in which they might be reinforcing deficit stereotypes around mathematics ability. For example, attending to RIs can show whether teachers engage in RIs with immigrant students that frame ability negatively or, whether these students experience a lack of positive framing of ability in mathematics. The authors think the current work provides a way to codify observable classroom interactions in a way that can tease out the relationships that students are building with teachers and mathematics. In turn, as the field continues to develop a more nuanced understanding of this phenomenon, we can bring new opportunities for teachers to further develop skills around supporting students relationally in mathematics.

While we often focus on teaching in urban schools on dimensions such as problem solving, mathematical discussions, and cognitive depth, this focus on content instruction may overlook relational dimensions and there is much to gain in attending to this as a mechanism that impacts student learning in mathematics (Battey et al., 2016). In fact, as a field, we may be underestimating the impact of instruction on student learning when not considering relational dimensions of the mathematics classroom. Therefore, future work that examines the impact of RIs on student identity, learning, and achievement would be helpful in furthering the field's understanding of how to better support teachers in building mathematical relationships. While quality content instruction is necessary, it may be insufficient in generating the kinds of student understanding that the field aims for, specifically for historically marginalised students.

References

Anthony, G., & Walshaw, M. (2007). *Effective pedagogy in mathematics/pāngarau: Best evidence synthesis*. Wellington: Ministry of Education.

Averill, R. (2012a). Caring teaching practices in multiethnic mathematics classrooms: Attending to health and well-being. *Mathematics Education Research Journal*, *24*(2), 105-128.

Averill, R. (2012b). Reflecting heritage cultures in mathematics learning: The views of teachers and students. *Journal of Urban Mathematics Education*, *5*(2), 157-181.

Bartell, T. (2011). Caring, race, culture, and power: A research synthesis toward supporting mathematics teachers in caring with awareness. *Journal of Urban Mathematics Education*, *4*(1), 50-74.

Battey, D. (2013). "Good" mathematics teaching for students of color and those in poverty: The importance of relational interactions in instruction. *Educational Studies in Mathematics*, *82*(1), 125-144.

Battey, D., Neal, R., Leyva, L., & Adams-Wiggins, K. (2016). The interconnectedness of relational and content dimensions of quality instruction: Supportive teacher–student relationships in urban elementary mathematics classrooms. *Journal of Mathematical Behaviour, 42*, 1-19.

Bishop, R., Berryman, M., Tiakiwai, S., & Richardson, C. (2003). Te Kotahitanga: *The experiences of year 9 and 10 Māori students in mainstream classrooms*. Hamilton: Māori Education Research Institute (MERI), School of Education, University of Waikato.

Boaler, J. (2006). How a detracked mathematics approach promoted respect, responsibility, and high achievement. *Theory into Practice*, *45*(1), 40-46.

Boaler, J., & Staples, M. (2008). Creating mathematical futures through an equitable teaching approach: The case of Railside School. *The Teachers College Record*, *110*(3), 608-645.

Boylan, M. (2009). Engaging with issues of emotionality in mathematics teacher education for social justice. *Journal of Mathematics Teacher Education*, *12*(6), 427.

Civil, M. (2007). Building on community knowledge: An avenue to equity in mathematics education. In N. Nasir & P. Cobb (Eds.), *Improving access to mathematics: Diversity and equity in the classroom* (pp. 105–117). New York: Teachers College Press.

Cole, J. M. & Boykin, A. W. (2008). Examining culturally structured learning environments with different types of music-linked movement opportunity. *Journal of Black Psychology, 34*(3) 331-355.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches* (2nd edition). Thousand Oaks, CA: Sage Publications.

Dominguez, H., LópezLeiva, C. A., & Khisty, L. L. (2014). Relational engagement: Proportional reasoning with bilingual Latino/a students. *Educational Studies in Mathematics*, *85*(1), 143-160.

Eccles, J. S. (2004). Schools, academic motivation, and stage-environment fit. In R. M. Lerner & L. Steinberg (Eds.), *Handbook of adolescent psychology* (2nd ed., pp. 125–154). Hoboken: John Wiley.

Empson, S. (2003). Low performing students and teaching fractions for understanding: An interactional analysis. *Journal for Research in Mathematics Education, 34*, 305–343.

Feagin, J. R., Vera, H., & Imani, N. (2001). *The agony of education: Black students at White colleges and universities* (2nd ed.). New York: Routledge.

Featherstone, H., Crespo, S., Jilk, L., Oslund, J., Parks, A., & Wood, M. (2011). *Smarter together! Collaboration and equity in the elementary math classroom*. Reston, VA: National Council of Teachers of Mathematics.

Ferguson, A. (2000). *Bad boys: Public schools in the making of black masculinity*. Ann Arbor: University of Michigan.

Ferguson, P., Gorinski, R., Wendt-Samu, T., & Mara, D. (2008). *Literature review on the experiences of Pasifika learners in the classroom.* Wellington, New Zealand: Ministry of Education.

Fletcher, J., Parkhill, F., Fa'afoi, A., Taleni, L. T., & O'Regan, B. (2009). Pasifika students: Teachers and parents voice their perceptions of what provides supports and barriers to Pasifika students' achievement in literacy and learning. *Teaching and Teacher Education, 25*, 24–33.

Forman, E., & Ansell, E. (2001). The multiple voices of a mathematics classroom community. *Educational Studies in Mathematics, 46*, 115–142.

Gonzalez, N. Andrade, R., Civil, M., & Moll, L. (2001). Bridging funds of distributed knowledge: Creating zones of practices in mathematics. *Journal of Education for Students Placed at Risk, 6*(1&2), 115-132.

Gorgorió, N., & de Abreu, G. (2009). Social representations as mediators of practice in mathematics classrooms with immigrant students. *Educational Studies in Mathematics*, *72*(1), 61-76.

Gregory, A., Skiba, R. J., & Noguera, P. A. (2010). The achievement gap and the discipline gap: Two sides of the same coin? *Educational Researcher*, *39*(1), 59-68.

Gregory, A. & Weinstein, R.S. (2008). The discipline gap and African Americans: Defiance or cooperation in the high school classroom. *Journal of School Psychology, 46*(4), 455-475.

Hackenberg, A. J. (2010). Mathematical caring relations in action. *Journal for Research in Mathematics Education*, 236-273.

Hill, J., & Hawk, K. (2000). *Making a difference in the classroom: Effective teaching practice in low decile, multicultural schools*. Wellington: Ministry of Education.

Howard, P., & Perry, B. (2005). Learning mathematics: Perspectives of Australian Aboriginal children and their teachers. In H.L. Chick & J.L. Vincent (Eds.), *Proceedings of the 29th Conference of the International Group for the Psychology of Mathematics Education* (PME), Vol. 3 (pp. 153–160). Melbourne: PME.

Hunter, R. (2008). Facilitating communities of mathematical inquiry. In M. Goos, R. Brown, & K. Makar (Eds.). *Navigating currents and charting directions: Proceedings of the 31st annual conference of the Mathematics Education Research Group of Australasia* (Vol. 1, pp. 31–39). Brisbane, Australia: Mathematics Education Research Group of Australasia.

Hunter, R., & Anthony, G. (2011). Forging mathematical relationships in inquiry-based classrooms with Pasfika students. *Journal of Urban Mathematics Education, 4*(1), 98–119.

Jerome, E. M., Hamre, B. K., & Pianta, R. C. (2009). Teacher–child relationships from kindergarten to sixth grade: Early childhood predictors of teacher-perceived conflict and closeness. *Social Development, 18*, 915–945.

Jorgensen, R., Grootenboer, P., Niesche, R., & Lerman, S. (2010). Challenges for teacher education: The mismatch between beliefs and practice in remote Indigenous contexts. *Asia-Pacific Journal of Teacher Education*, *38*(2), 161-175.

Ladson-Billings, G. (1997). It doesn't add up: African American students' mathematics achievement. *Journal for Research in Mathematics Education, 25*(6), 697-708.

Leder, G., & Grootenboer, P. (2005). Affect and mathematics education. *Mathematics Education Research Journal*, *17*(2), 1-8.

Lubienski, S. T. (2002). A closer look at Black-White mathematics gaps: Intersections of race and SES in NAEP achievement and instructional practices data. *The Journal of Negro Education, 71*(4), 269 - 287.

Monroe, C. (2005). Why are "bad boys" always Black? *The Clearing House*, 79(1), 45-50.

Moschkovich, J. N. (2007). Using two languages when learning mathematics. *Educational Studies in Mathematics, 64*(2), 121–144.

Murray, C., Waas, G. A. and Murray, K. M. (2008), Child race and gender as moderators of the association between teacher–child relationships and school adjustment. *Psychology in the Schools, 45*, 562–578.

Neal, L. I., McCray, A. D., Webb-Johnson, G., & Bridgest, S. T. (2003). The effects of African American movement styles on teachers' perceptions and reactions. *Journal of Special Education, 37*(1), 49–57.

Neal, R. A. & Battey, D. (2014). Opening classroom spaces for the mathematical success of African American and Latino/a Students. *TODOS Research Monograph, 3*, 50-64.

Pianta, R. C., & Stuhlman, M. W. (2004). Teacher-child relationships and children's success in the first years of school. *School Psychology Review*, *33*(3), 444-458.

Povey, H. (2003). Teaching and learning mathematics: Can the concept of citizenship be reclaimed for social justice? In L. Burton (Ed.), *Which way social justice in mathematics education* (pp. 51–64). Westport, CT: Praeger Publishers.

Setati, M. (2008). Access to mathematics versus access to the language of power: the struggle in multilingual mathematics classrooms. *South African Journal of Education*, *28*(1), 103-116.

Setati, M., & Adler, J. (2000). Between languages and discourses: Language practices in primary multilingual mathematics classrooms in South Africa. *Educational Studies in Mathematics*, *43*(3), 243-269.

Solórzano, D. G., Allen, W. R., & Carroll, G. (2002). Keeping race in place: Racial microaggressions and campus racial climate at the university of California, Berkeley. *Chicano-Latino Law Review, 15*(23), 15-111.

Stiff, L. V., & Harvey, W. B. (1988). On the education of black children in mathematics. *Journal of Black Studies, 19*(2), 190-203.

Turner, E., Dominguez, H., Maldonado, L., & Empson, S. (2013). English learners' participation in mathematical discussion: Shifting positionings and dynamic identities. *Journal for Research in Mathematics Education, 44*(1), 199–234.

Waddell, L. R. (2010). How do we learn? African American elementary students learning reform mathematics in urban classrooms. *Journal of Urban Mathematics Education*, *3*(2), 116-154.

Walshaw, M., & Anthony, G. (2008). Creating productive learning communities in the mathematics classroom: an international literature review. *Pedagogies: An International Journal*, *3*(3), 133-149.

Warren, E., Cooper, T.J., & Baturo, A.R. (2010). Pedagogies to support Indigenous students' mathematics learning in rural and remote Queensland classrooms. In J. Zadja (Ed.), *Gobalisation, education and social justice.* Globalisation, Comparative Education and Policy Research Series. Dordrecht, the Netherlands: Springer.

Wood, M. B. (2013). Mathematical micro-identities: Moment-to-moment positioning and learning in a fourth-grade classroom. *Journal for Research in Mathematics Education*, *44*(5), 775-808.

Authors

Dan Battey
Graduate School of Education
Rutgers University
10 Seminary Place, 232
New Brunswick, NJ USA 08901
email: dan.battey@gse.rutgers.edu

Rebecca A. Neal
West Building 229
1536 Hewitt Ave.
Hamline University
St Paul, MN USA 55104
email: rneal01@hamline.edu