



Responding to negative emotion in a pre-service mathematics classroom

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Abstract

Emotions associated with prior mathematics learning experiences endure for some pre-service teachers, leaching into their own teaching of mathematics. Taking a sociology of emotions framing, the naturalistic study used event-oriented social inquiry and employed multiple methods (classroom transcripts, interviews, email conversations and reflective notes). In the event selected for this paper, we identified the importance of teacher educators intentionally attending to emotions in pre-service mathematics classes to address a dominant cognitive emphasis in learning to teach mathematics. We found that collective empathy was central to an emotional climate in which responses to individual and collective emotions were considered. We argue that collectively creating an emotionally safe environment in pre-service teacher education can help disrupt cycles of negative emotion associated with mathematics.

Keywords Emotion · Pre-service teacher education · Mathematics · Emotional climate · Collective empathy

Emotions and mathematics education

Preparing future teachers has traditionally included a strong emphasis on the cognitive aspect of teaching, overshadowing the all-important emotional aspect. In the 1990s, Andy Hargreaves was one of the few commentators to note the relationship between teaching and emotions, arguing that good teaching is “charged with positive emotion” (Hargreaves 1998, p. 835). More recently, Konstantinos Alexakos (2015) highlighted the neglect of emotions in theories of human cognition and education. Stephen Ritchie (2018) observed that the

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dominance of the cognitive emphasis overshadowed research on emotions in teaching and learning and urged us to pay attention to emotions in classrooms.

A growing body of research has contributed to increasing knowledge about the unique emotional demands on pre-service teachers, in the contexts of teacher education courses and school-based practicum (see Bellocchi 2019). Topics of study have included the relationships between emotions and efficacy, and the development of teacher identity during practicum (e.g., Yuan and Lee 2015). Research specifically with pre-service mathematics teachers has investigated developing emotional literacy as a means to strengthening pedagogical confidence in teaching mathematics (Yeigh et al. 2016), pre-service teachers' identity development (Bobis, Nguyen and McMaster 2021), and how beliefs, emotions and attitudes towards mathematics contribute to the enjoyment of teaching (Marbán, Palacios and Maroto 2021).

Mathematics anxiety is a much-researched emotion, and has been defined as “feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations” (Richardson and Suinn 1972, p. 551). Since Frank Richardson and Richard Suinn's development of a scale to measure mathematics anxiety, this emotion has continued to be a particular focus in relation to pre-service teachers (e.g., Bekdemir 2010; Brady and Bowd 2005; Olson and Stoehr 2019). Much of this work has made individual pre-service teachers' mathematics anxiety explicit, and supported their reflection on how their emotion can affect their future students. However, many of these studies have stopped short of investigating approaches to intentionally reducing—or eliminating—pre-service teachers' mathematics anxiety.

Lower levels of teachers' anxiety about teaching mathematics are related to increased student mathematics achievement (Hadley and Dorward 2011). Additionally, Alana Foley and colleagues (2017) showed a reciprocal relationship between students' anxiety and performance in mathematics. An implication here is that reducing pre-service teachers' mathematics anxiety could help build their future students' achievement, thereby also interrupting a cycle of intergenerational reproduction of mathematics anxiety. Researchers have recognized this is a pressing issue and have been exploring various strategies for reframing pre-service teachers' mathematics anxiety. These strategies have included: matching pre-service teachers with expert teachers as mentors (Perkins 2015); strengthening pre-service teachers' conceptual understanding of mathematics to reduce their anxiety (Brown and O'Keeffe 2016); and supporting pre-service teachers to examine their past experiences associated with their mathematics anxiety and the emotion they invoke to help them reduce their anxiety and become better teachers (Wilson 2016). In New Zealand, Naomi Ingram, Chris Linsell, and Bilinda Offen (2018) have investigated pre-service teachers' relationships with mathematics and how these could be positively impacted by teacher educators. Effective strategies they identified included deliberately strengthening pre-service teachers' mathematical content knowledge, explicitly highlighting affective aspects, and showcasing practising teachers as positive role models.

Working in the field of critical mathematics education in the USA, Shaquana Wright-Chung (2022) used authentic inquiry in her study that aimed to make meaning of pre-service teachers' emotions to help promote their mental and physical well-being. Like Wright-Chung and other researchers who have been investigating strategies to tackle mathematics anxiety, we also want to disrupt the reproduction of pre-service teachers' negative emotional experiences associated with mathematics. Further, we aim to help them reconstruct positive relationships with mathematics, thereby contributing to improving their future

students' mathematics achievement. In this paper, we present a classroom event that illustrates how a teacher educator (Joanna, the first author) and her pre-service student teachers collectively create an emotionally safe environment in which to learn together, to examine how an awareness of emotion can disrupt cycles of negative emotion.

Interdependent relationship between emotion and teaching

We draw on sociological theories of emotion (Turner 2007, 2009) to underscore the importance of understanding the interdependent relationship between emotion and teaching in education settings. Alberto Bellocchi (2018) argues that developing self-awareness of emotional responses is important to becoming successful. Work over the past 35 years on categorising emotion includes Jonathan Turner's (2010) stratification of a large repertoire of emotions originating from the four primary emotions (anger, sadness, fear, happiness), three of which are negative, to enable a nuanced reading of emotional states in a pre-service mathematics class. The secondary emotions deriving from primary emotions are mixtures of negatively and positively valenced emotions. The intensity of emotions is generally accepted to vary from high to low (Davis and Bellocchi 2018, 2020). For example, anxiety is an emotion that Turner categorized as being a moderate intensity variant of the primary emotion aversion-fear and involves feelings of shame and anger at oneself.

Emotions tend to be regarded as located within individual learners (Zembylas 2007), but as Erving Goffman (1961) observed are sometimes concealed. The focus of this paper is on emotions being located not only within individuals, but also within the collective emotional climate, and illuminating the emotional complexities arising from learning to teach mathematics. We adopt Alberto Bellocchi, Stephen Ritchie, Kenneth Tobin, Maryam Sandhu and Satwant Sandhu's (2013) definition of emotional climate as "the collective state of emotional arousal produced by a class" (p. 530) in our examination of a pre-service mathematics classroom.

As part of the emotional climate, we are particularly interested in the notions of emotional arousal, social solidarity and empathy. We are interested in emotional arousal evident as a dramatic form of emotional energy in interactions to expand our understanding of social solidarity. Social solidarity is an important outcome of a successful interaction, and is defined by Randall Collins (2004) as having the characteristics of mutual focus, entrainment, and shared positive mood. In successful interactions, social solidarity can be evidenced through the generation of a symbol of a shared experience reproduced from a previous interaction, for example, a shared joke. The use of such a symbol can consolidate social solidarity (Davis and Bellocchi 2020). Additionally, social solidarity can be enhanced by empathetic or caring responses to an individual's affective dissonance, according to Michalinos Zembylas (2016).

How we went about our study

The research was designed as an interpretive study using event-oriented social inquiry (Tobin and Ritchie 2012) to account for the naturalistic setting of a pre-service teacher education classroom and help us in our ongoing research to generate insights into emotional climates in mathematics classrooms (Bonne and Higgins 2022). The three researchers are also experienced classroom teachers and educators of both in-service and pre-service

teachers, with an enduring interest in the relationship between emotions and mathematics education.

Following William Sewell Jr.'s (2005) notion of events as having a distinct beginning and end that frame a shift, Joanna and Raewyn selected two events from the data corpus that illustrated shifts in the emotions that showed "breaches in cultural enactment and ruptures of cultural equilibria" (Tobin and Ritchie 2012, p. 118). In both events, our attention was drawn to unexpected expressions of high emotion, not uncommon in classroom contexts (Alexakos 2015). We saw these events as important for transforming structures and contributing to social solidarity and an inclusive emotional climate (Tobin and Ritchie 2012). The event we focus on in this paper occurred in the fifth week of the mathematics component of the course.

The multiple data sources for this study were:

- transcripts of audio-recordings of teaching sessions (twice-weekly over eight weeks);
- one-off face-to-face interviews at the conclusion of the course with six pre-service teachers who played prominent roles in the two events;
- additional email clarification between the teacher educator and the pre-service teachers, following the event reported here; and
- reflective conversations to cogenerate insights about notable events that occurred and possible responses during subsequent classes between the two teacher educators, immediately before and after each class.

Convenience and purposive sampling was used as this was a naturalistic qualitative study (Miles, Huberman and Saldaña 2014) of a class taught by two of the authors of this paper. We identified a class of 43 pre-service teachers (elementary and secondary) for this study who were in their final year of the same four-year conjoint degree programme of study, and all gave written consent in accordance with the university's ethics requirements. Joanna was the primary teacher educator and co-taught the class with Raewyn which was critical to generating reflexive conversations over the duration of the course. Our co-teaching praxis followed the principles defined by Roth and Tobin (2002) of taking shared responsibility for action alongside ongoing collective sense-making of the sessions.

The course comprised 16 sessions over an 8-week period, spanning an 8-week school-based teaching practicum halfway through. Each of the sessions focused on different mathematics pedagogical content knowledge, for example, the progression from concrete to imaging to abstract thinking to solve addition and subtraction problems.

The specific data we draw on in this paper are transcripts of audio recordings of two consecutive classes in the lead-up to the pre-service teachers' major teaching practicum and include an event which we will show contributes to the class's social solidarity and inclusivity. Additionally, we have used interviews and email conversations. The analytical phase was initiated during the data collection phase of the study, when this event was identified for close analysis because of its high emotional content. Such dramatic forms of emotional energy make emotions—often concealed—visible to the collective and make emotions accessible for analysis and interpretation.

As with other investigations in our larger body of research (e.g., Bonne and Higgins 2022), we followed a hermeneutic phenomenological framing (Tobin and Alexakos 2021) in our data analysis where we considered the questions, what is happening during the session, why is it happening and what more is there? In this analysis, our specific focus was on the interdependence of emotions and teaching. We describe and analyse the production of emotions and how these provided opportunities for the teacher educator to lead discussions

about the importance of raising awareness of emotional responses with the purpose of disrupting cycles of negative emotion (for instance, anxiety).

What follows is our analysis of this event, presented in three extracts, that illustrates how the emotional climate was cogenerated by the teacher educator and pre-service teachers in the context of these classes. We then unpack the turns taken to highlight the emotions that the data made accessible. We follow this with a higher level commentary across all three extracts that comprise the event and then consider the implications for fostering collective empathy to enhance the emotional climate of mathematics classrooms.

One student's emotional response to the game

As people arrived for class, one student (Sarah) asked if the class could play a mathematics game. She confirmed that she had one in mind, and the teacher educator (Joanna) promised her they would play the game once they had finished where they left off the previous day with the multiplication and division lecture. After about an hour and a half the formal teaching about multiplication and division ended. At that point Joanna noticed a subdued energy and suspected that the students were tired of listening, even though the class had included opportunities for them to discuss their strategies for solving multiplication and division problems in small groups. Joanna also realized that she needed to leave enough time for Sarah's game and invited Sarah up to the whiteboard at the front of the lecture theatre to lead.

Sarah's game was followed by a common turn-taking whole-class game used to practise multiples, called Buzz. Joanna reminded the students that: "It's the one where you're going to say buzz on multiples of a number. We might start easy, with say, multiples of two. Every time there is a multiple of two, you must be ready, we will go quickly, and you 'buzz'. But then we might make it harder." For example, for multiples of two the first player would say "one", the next player, "buzz", and the third player would say "three", the next player "buzz", the next "five" and so on, with "buzz" being the response on every second number or multiple of two. Typically, a game of Buzz begins with students standing in a circle and turns proceed individually around the circle with a student sitting down if they miscount or say "buzz" in the wrong place in the counting sequence. Play continues until one student is left standing. Although the game starts with every student in a class participating, the success or failure of each student's performance is watched by their peers and the teacher. Joanna introduced the game by asking if anyone was familiar with it and wanted to lead it. Taking into account the physical layout of the lecture theatre, she suggested getting started by going along the rows, jumping over the aisles, and weaving along and up each row. Extract 1 shows the beginning of a game of Buzz with multiples of three, in which Helen does not say "buzz" where she should.

Extract 1: An expression of emotion

4	Students	[taking turns] one, two, buzz, four, five, buzz, seven, eight, buzz, ten, eleven, buzz, thirteen, fourteen
5	Helen	Fifteen. [loudly and angrily] That's why I don't like this game. Because it's an individual thing, and I sucked at multiples, and I'd go out first, and everyone would make fun of me. It's the individual failure I hate. Because it makes you feel like crap
6	Joanna	Hmm. fair point
7	Chris	Maybe you could run the game and have someone sit it out if they didn't feel comfortable?

8	Joanna	Maybe. Let's ask the class
9	Sam	Set boundaries earlier. No hassling. Anyone who hassles can sit out
10	Nick	We could have a referee
11	Joanna	It's hard. You do want something inclusive. You do want everyone participating. And maybe you give people an option of sitting out. Maybe that was my mistake. And I could have asked, who wants to sit out?
12	Helen	I didn't mean to get upset
13	Joanna	That's alright. I don't mind. It's important to discuss these things. That's exactly the sort of thing we should discuss, in terms of our emotions that engaged your emotions. As a teacher, or as a participant. Thinking as a teacher. And that's fine. I would say—trust your emotions. If this is a thing you feel strongly about—that it's too individual—then don't use it as an activity. There's no problem with that
14	Students	[game resumes, taking turns] eleven, buzz, thirteen, fourteen, buzz, sixteen, seventeen, buzz, nineteen, twenty, buzz, twenty-two, twenty-three, buzz. [applause, some laughter]

In Turn 5, Helen expresses her emotion about the error she made during play, and by doing so, makes her emotion visible to the group. Putting her emotion into highly descriptive language (such as failure, hate, crap), she conveyed her previously negative learning experiences in mathematics classrooms. Her strong dislike of mathematics games was amplified by her angry tone of voice. As shown in Turn 7, one student empathized with Helen's apparent discomfort and suggested that those not feeling comfortable playing a game could opt out. The emotionally charged outburst appeared to take Helen herself by surprise. In Turn 12, she said to the class she didn't mean to get upset, seemingly prompted by a mix of embarrassment and shame. Ironically, Helen's outburst ruptured the flow of class interactions associated with the playing of the game and diverted the attention of the teacher and the class to focus on her—exactly the attention she had probably wanted to avoid.

Later reflecting on her outburst in an email exchange with Joanna, Helen explained, “that is exactly why I hate this game. It's so individual. The person who screws up is the centre of focus when they screw up”. She added, “all the focus is on one person so when they screw up, they're letting everyone down”. She wondered, “Is there a way to change the game so that the focus isn't always on one person”? When interviewed later, she expanded on her experiences: “That's the very reason that I hate these sorts of games. They individualize the maths. ... It brings back all the bad experiences that I had in maths at school”. In the interview, Helen told Joanna that she did have her hand up at the start of the game to say that she didn't want to play, but that Joanna hadn't noticed her raised hand. Helen described how she had experienced a fraught emotional relationship with game playing in school mathematics classes which was triggered by playing the same game in the mathematics education class. Although distressing at the time, for Helen at least, Joanna recognized this as an opportunity to discuss with the class emotions associated with learning mathematics.

After the session, Joanna and Raewyn talked about how having previously established with the students an explicit focus on the interdependent relationship between emotion and teaching had afforded an emotionally safe learning environment for students. Because the class was already focused on emotions it is perhaps not surprising that Helen felt safe to express her dislike arising from her previous experiences of playing the game of Buzz as a student. At the same time, Helen's fellow students and Joanna were well positioned to notice and respond to the emotions expressed.

Extract 1 ends in Turn 14 with the resumption of the game. A successful series of correct turns culminates after the final “buzz” with the group's spontaneous applause and

some laughter, injecting emotional energy. At this point, Joanna pauses to reflect on other ways of configuring the game (see Extract 2).

Empathy of the collective

Reframing the game of Buzz from an individual pursuit to be a more collective experience for everyone in the class was an opportunity to generate collective empathy towards fellow players and members of the class. This began with Joanna asking the class: “Is there another way of doing it? In a circle? Or more inclusively?”. Helen suggested: “Maybe have everyone say buzz.” Another student commented: “We need to be careful but we also as a society must encourage risk-taking, that’s my opinion, as a partially educated person. We create a safe environment.” Extract 2 shows what followed.

Extract 2: Playing collectively

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- 19 Joanna Thank you for prompting that discussion. I think this is a game where, maybe you’ve been on a teaching practicum where this was played. It is a game commonly played, and we have encountered some strong feelings about it. Which is fine. That’s good. Should we try it collectively?
- 20 Chris Choral counting, effectively
- 21 Joanna Let’s do it with multiples of sixes. We’ll all say buzz. We’ll start with George? Start with one
- 22 Class [in chorus] one, two, three, four, five
- 23 Alex Individually say the numbers, then we get to a buzz, and everyone says buzz
Multiples of sixes
- 24 Joanna Start with George again
- 25 Class [in chorus] one, two, three, four, five, buzz, seven, eight, nine, ten, eleven, buzz, thirteen, fourteen, fifteen, buzz [laughter]
- 26 Nick [light-heartedly] Damn it
-

The extract above shows how the collective play transpired. The suggested comparison to choral counting was unsurprising because this is a common classroom approach to support one another in the task of practising multiples and forward and backward counting, all aimed at highlighting mathematical structures and developing fluency with the number system. Within the collective environment of this activity there is space for individuals to go unnoticed if they miss the right moment to say “buzz”—or to light-heartedly say “damn” in response to a mistake. The collective framing changed the emotional dynamics of such “mistakes” to moments of collective enjoyment rather than moments of individual shame, as evidenced by the laughter rippling forth when the class buzzed on 16 in Turn 25.

In Extract 3, Joanna initiates a reflective discussion focusing on emotions to reframe the game as a collective activity. Of note in Extract 3 is reference to what one of the students had labelled “a gift” in an event during class the week before. The “gift” metaphor represented a classroom interaction in which the teacher appropriated a student utterance as a collective resource for illustrating a pedagogical point. This had emerged when a student had made an error during class and members of the group reframed it to highlight the potential learning opportunities, and coined the term, “gift”.

Extract 3: Collective reflections

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- 27 Joanna Let’s unpack that new moment. What was different about that new moment? There was something different about that new moment of error
-

-
- 28 Nick I just gave a gift because I still looked stupid because I yelled out buzz. There was still room for individualism
- 29 Sam Yeah, damn...
- 30 Joanna What was very different, to me, standing here, was that there was a collective effervescence of laughter. That wasn't there before when we unpacked the actual game. That's about the learning environment
- 31 Nick I think it's because I made a point of it being, there's no way there'll be individual failure here, but it turns out there was
- 32 Joanna That's really interesting. What's interesting in terms of the lesson, about the learning environment that you can take from it, is that that moment, is that there was a great surge of positive energy with the laughter. ... That's what Ken Tobin would say, those moments where you get the laughter, that's positive energy. If we could measure the positive energy, the voice, the noise of the room-
- 33 Alex Decibels?
- 34 Joanna No, the quality of the sound. It would have been bubbling full of energy. Don't we all feel a bit better now? There's something to take away from maths games. It was a powerful example of the power of laughter. It was everybody 'laughing with'. Whereas perhaps before there was a danger that we were 'laughing at'
- 35 Sophie I feel like the second mistake you could still continue as a class is that the game doesn't have to break down, whereas with individuals, it must stop
- 36 Joanna Something to think about as you embark on next week when you're on teaching practicum
-

In the collective reflection in Extract 3, Nick's comments indicate that making an error during collective play could still make an individual look stupid (Turn 28) and experience a sense of failure (Turn 31). Sophie points out that this need not interrupt the game in the same way it did when the play focused on individuals' counting—and therefore on individuals' mistakes (Turn 35).

In contrast to Helen's outburst that we saw in Extract 1, Joanna highlights the more positive effect of mistakes being made when the game is played collectively. Joanna describes the laughter that erupted as "a collective effervescence of laughter" (Turn 30) and "a great surge of positive energy with the laughter" (Turn 32), differentiating between sheer volume and quality of sound (Turn 34). In Turn 34, Joanna also makes a distinction between 'laughing with' and 'laughing at', the former suggesting everyone laughed together about the mistake, while the latter suggests the person making the mistake was the focus of the laughter.

We take the position that the individual is in a dialectic relationship with the collective which enables a nuanced reading of interactions during classroom events, such as those in Extracts 2 and 3. Unlike Helen's recounted experience in Extract 1 of individual isolation when she made a mistake, the shared mood of the game playing established a safe-to-fail environment for collective participation, even though individual mistake-making was still visible. Perhaps the empathetic response to Helen's emotional outburst that shifted the collective focus away from a person who makes a mistake, may also have somewhat eased Helen's expressed hate of game playing. At the same time, this shift contributed to the collective enjoyment of the activity as evidenced by the ripple of laughter.

Calling a mistake a "gift" helped to reframe a potentially negative experience for one person and contributed to the production of the shared culture of that group of learners (Roth and Tobin 2002). The use of the "gift" metaphor by both Joanna and Nick can be seen as a symbol of a shared experience that contributed to group solidarity. Subsequently, members of the group used the term as a label or shorthand for the shared experience that carried meaning across time as an emotional resource for all participants to

appropriate and contribute to building an emotionally safe learning environment. The adoption of this particular gift enabled the game to be reframed from an individual to a collective activity, changing the expectation for individual students to give correct answers without the support of others, to participating in a shared, supported task. Turn 35 illustrates that when played collectively, an error does not stop the game play and individual mistakes tend to be subsumed and the momentum sustained. We argue that “the gift” was an important tool that helped maintain the emotional climate in situations that had the potential to be emotionally unsafe.

Commentary across the extracts

Emotions are ever-present in interactions, but not always openly expressed (Goffman 1961). The highly visible expression of emotions in this event prompted us as experienced teacher educators and classroom researchers to critically examine what was happening in this moment and why. The expression of Helen’s emotion provided material for both the teacher educator and the pre-service teachers, including Helen herself, to interpret. In this interaction, context where Joanna is facilitating a whole-class game, her concerns are maintaining an emotionally safe learning environment at the same time as modelling the teacher role for the students. When Helen expressed her intense emotions to the group, Joanna sensed Helen’s shame and anger in her tone of voice and use of language in exposing, rather than concealing, how she felt in front of the class, and offered an empathetic response. Helen’s emotional outpouring aligns with Goffman’s description of the usually contained emotion erupting as a “flooding out” (1961, p. 55).

Helen’s emotional outburst can be explained through Turner’s (2010) suggestion of emotional arousal occurring under two conditions of expectations and sanctions. By expectations, he means “what should and will transpire” (p. 186), which for Helen was the expected failure and associated shame around taking her turn in calling the next number. Had we not been explicitly focusing on emotions, one way Joanna and the students might have responded to Helen to appease or deflect the emotion would have been to simply abandon the game. We suggest that this would have been a positive sanction to Helen’s expectation that results in reproducing Helen’s cycle of experiencing shame in association with mathematics. Instead, an explicit orientation towards emotions associated with mathematics learning enabled a response to expressed emotion that took the focus off individuals while maintaining momentum of the game. Rather than Helen’s outburst being met with a negative sanction, it opened up an opportunity for Joanna to positively sanction her expressed emotion and discuss the emotional climate of a mathematics classroom.

The event under examination shows how an explicit collective examination of the emotional experience for one of the players generated several possibilities for restructuring play. Interestingly, the suggestions included both inclusion and exclusion strategies of players, as well as adding the role of referee. The empathy of the group was evident through students’ suggested ways of modifying the game to downplay the emphasis on individual performance and create a safe emotional learning environment. This is what Zembylas (2007) describes as creating caring safe ecologies in which the whole class is concerned about everybody’s emotional well-being. It is perhaps worth noting that this shift in focus was initiated by Joanna and picked up by the students. Their suggested responses to the outburst of emotion indicated a consideration of the potential effect of the structure of the activity on including all participants. In fact, most of the suggestions in the discussion around inclusion were focused on observable compliance with the game’s convention of

buzzing on the nominated multiple. Attending to emotions is harder because they are not necessarily observable and are more difficult to interpret.

The playing of the Buzz game can be seen as the enactment of culture in a classroom whereby culture is produced through patterns of coherence and contradictions (Tobin and Alexakos 2021). While Helen's emotional outburst was productive | reproductive, it was also transformative. At that moment, she produces negative emotion that is historically constituted from her previous experiences of learning mathematics in a cycle of production | reproduction. Helen herself wondered if the game could be changed to take the focus off an individual performance. Together, the students offered ideas to enhance the collective emotional climate of the game setting, illustrating the way in which students' collective empathy can help ensure an emotionally safe learning environment in which individuals' emotions are considered as an enactment of culture. In the Buzz event, Joanna promoted the collective examination of the emotional aspect of the learning environment. Together, Helen's emotional outburst and the collective responses ruptured the pattern of coherence and catalyzed a transformation. We suggest the shared experience of playing the game provided opportunities to discuss how to create a safe emotional climate and potentially break the cycle.

Discussion

In the context of pre-service classrooms, our findings suggest the need for teacher educators to direct student teachers to consider emotions in teaching and learning mathematics, bringing attention to how discourses about mathematics impact the emotional climates they cogenerate with children. We note the enduring and intergenerational entanglement between emotions and teaching of mathematics and the challenge of transforming stubborn discourses, such as mathematics anxiety (Foley et al. 2017). To date, efforts made to address mathematics anxiety for both students and teachers include making mathematics fun. However, it is more important to expand the discourse and examine emotions such as anxiety, strongly associated with the primary emotion of aversion-fear (Turner 2007). Dealing with anxiety by redirecting students' attention from the cognitive challenges associated with learning mathematics by casting mathematics as "fun" (Walkerdine 1988) can be problematic because it can perpetuate a cycle of underachievement. Similarly, avoiding mathematics is a self-perpetuating strategy that unintentionally reinforces students' aversion and relationship with mathematics (Whyte and Anthony 2012).

Taking a perspective beyond anxiety alone and investigating pre-service teachers' relationships with mathematics (Ingram, Linsell, and Offen 2018), expands the debate about emotions in mathematics classrooms. To this end, Susanna Wilson (2016) argued that more explicit attention to pre-service teachers' past experiences of learning mathematics and associated emotions is important to their preparation to become teachers of mathematics. Indeed, teachers' relationships with mathematics ultimately influence their students' mathematics achievement (Hadley and Dorward 2011). Our study additionally showed how explicit attention to an emotional outburst provided an opportunity to explore pre-service teachers' relationships with mathematics based on their prior experiences as learners.

Essential to our instruction was modelling to pre-service teachers how a robust emotional climate enabled productive discussions of previously concealed emotions (Goffman 1961). We agree with Zembylas (2016) that failing to attend to emotion in mathematics classrooms has serious implications for teaching and learning. We have shown how an

explicit collective examination of the emotional experience for one of the players generated several possibilities for restructuring play. The empathy of the group was evident through students' suggested ways of modifying the game to downplay the emphasis on individual performance and create a safe emotional environment.

We reflect on what this means for how we teach pre-service teachers and how we work with them in light of their prior emotional experiences and memories of learning mathematics. Childhood experiences such as Helen's can later lead to individual emotions of exclusion and frustration. Emotions are at the core of social life as structures that transcend situations and are carried across time and place, as we have shown. The teacher educator's attention to emotions was perhaps unexpected and enabled the collective to consider the importance of emotions in mathematics classrooms. Redressing the balance of emotions and cognitions is contingent on emergent classroom events and the power of the collective, illustrated through the group's empathetic responses.

Concluding thoughts

Reframing negative discourses about mathematics is long overdue, and is challenging work. Our work builds on Wright-Chung's (2022) to make an argument for intentionally exploring emotion during pre-service teacher mathematics education classes, at present not adequately promoted. In the case of pre-service teachers, emotional responses associated with prior mathematics learning experiences can endure, leaching into their own teaching of mathematics. How we prepare and work with pre-service teachers is critical to disrupting their enduring prior and often hidden emotional experiences and memories of learning mathematics. One way to do this is for teacher educators to intentionally create and maintain inclusive mathematics classrooms characterized by collective caring and empathy (Zembylas 2007). In the event reported here, the pre-service teachers' and teacher educator's collective empathy promoted a safe learning environment in which individual and collective emotions were considered, where empathy was central to the emotional climate.

This paper is limited to the close examination of a single event, albeit drawing on multiple data sources. Unlike other studies (e.g., Brady and Bowd 2005), we did not directly set out to interrogate pre-service teachers' prior experiences of learning mathematics at school. Rather we examined the emotions that emerged during the teaching of the class that were contingent on the activities that were undertaken. We do not know whether Helen's negative emotion associated with mathematics endured, following these classes. Future research could take a longitudinal approach to investigate the enduring nature of shifts in pre-service teachers' emotional orientation to mathematics, critical to breaking cycles of reproduction of negative emotion.

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