ORIGINAL ARTICLE

Unpacking mathematics preservice teachers' conceptions of equity

Rebecca McGraw[1] · Anthony Fernandes[2] · Jennifer A. Wolfe[1] ·
Becca Jarnutowski[1]

Abstract

This report describes initial findings from a larger study conducted in the USA focusing on mathematics teacher preparation and beginning teacher practice as they relate to equity. We particularly address in this report a gap in the literature with respect to pre-service teachers' conceptions of equity and equitable practice as they relate to issues of identity and power at the end of their teacher education programs. Interviews of 33 students near the completion of their teacher education programs were analyzed using Gutiérrez's four dimensions of equity—access, achievement, identity, and power. Our findings suggest that these pre-service teachers had ways of thinking about these domains that were both varied and nuanced, with many students describing critical aspects of equitable instruction including attention to bias, representation, student participation, and classroom power structures. Our findings are consistent with prior research in that future teachers described many ideas related to equitable teacher practice that focused on access to mathematics, and, in many cases, deficit perspectives persisted. At the same time, our study suggests that beginning teachers may complete their education programs with critical knowledge around equity that could provide fertile ground for further professional learning.

Keywords Equity · Mathematics · Teaching · Identity · Power

✉ Rebecca McGraw
  rmcgraw@math.arizona.edu

1   Department of Mathematics, The University of Arizona, Tucson, AZ, USA

2   Department of Mathematics and Statistics, University of North Carolina-Charlotte, Charlotte, NC, USA

Ⓐ Springer

Introduction

Education systems can function in ways that limit access and advancement in mathematics for students from nondominant groups (Organisation for Economic Co-operation and Development [OECD], 2018). Separating students by perceived abilities reflecting norms of the dominant group; perceiving language, culture, and experiences of nondominant groups as a deficit or something to be ignored; removing students unnecessarily from classrooms and using biassed placement methods; and distributing resources inequitably are common examples among many. As a result, a disproportionate number of students from nondominant groups find themselves in mathematics classes where expectations are low (Gutiérrez, 2002; Tate, 1995), resources are scarce (McFarland et al., 2017), and opportunities for advancement are few (Gamoran & Hannigan, 2000; Moses & Cobb, 2001; Roberts, 2009).

Educational opportunities and experiences for nondominant students have been a focus of study across numerous countries. For example, the Aboriginal and Torres Strait Islander students in Australia (Miller & Armour, 2021), Pasifika and Māori students in New Zealand (Averill & Rimoni, 2019; Meaney, et al., 2013; Turner et al., 2015), Black and Mixed race students in South Africa (Draper et al., 2017; Maimane, 2014), scheduled caste and scheduled tribe students in India (National Council for Teacher Education [NCTE], 2009), and the First Nations, Métis, and Inuit students in Canada (Flanagan, 2018). Often, these studies find teachers view nondominant students as less capable and have lower expectations for these students, although studies do report ways in which communities and teachers/schools can partner to achieve more equitable and empowering experiences for students (e.g., Meaney, et al., 2013).

To challenge inequities in access and advancement, teachers must reject the notion of fixed ability, recognize variety in students' skills and knowledge as resources for learning (rather than hindrances), maintain high expectations for all students, and use knowledge of bias and systemic inequity to recognize problems and take action. Expectations for teachers are high, including for those who are early in their careers. For example, according to the US Association of Mathematics Teacher Educators (AMTE) (2017), "Beginning teachers must be aware of, value, and draw upon learners' social, cultural, and linguistic resources (González et al., 2005); know learners' histories; and recognize and work to change how power relationships and deficit views affect students' mathematical identities, access, and advancement in mathematics (e.g., Gutiérrez, 2013b; Martin, 2015; Strutchens et al., 2012; Wager, 2012)" (p. 7).

Across nations, standards reflect expectations that teachers be culturally responsive, reflect on personal biases, develop non-deficit views about students, draw on students' culture and communities in their teaching, and build connections with families and communities. For example, the Australian Institute for Teaching and School Leadership (2022) has standards requiring teachers to reflect on who they are, including their world views and implicit biases, and develop non-deficit views of Aboriginal and Torres Strait students. Similar

standards are in place in New Zealand where the Education Council New Zealand (2011) outlined cultural competencies teachers need when engaging with Pasifika and Māori students. The National Curriculum Framework for Teacher Education (NCTE, 2009) in India requires teachers to develop social sensitivity and consciousness and connect school curriculum to community knowledge outside of school. The South African Council for Educators (2020) goes further and requires teachers "have a responsibility to identify and challenge policies and practices that discriminate against, marginalize, or exclude learners" (Standard 3.2).

Related literature

Research shows PSTs tend to perceive the diversity of students within a classroom negatively, focus on individual traits and differences as opposed to widespread and systemic inequities, and view "good teaching" and "fairness" as cures for the "diversity problem" (Causey et al., 2000; Gay, 2015; Houser & Chevalier, 1995; Schofield, 2010). According to Gay (2015), "The prevailing ideological preference [among both PSTs and in-service teachers] is still claims of colorblindness, denial of widespread educational and societal inequalities, and the pre-eminence of de-contextualized individuality" (p. 440). In addition, because mathematics is widely perceived to be objective and free of bias, issues of equity may be less salient to PSTs.

Researchers investigating PST development as it relates to equity have identified clusters of equity-related beliefs that tend to be exhibited by PSTs entering their preparation programs including a desire to act fairly by treating all students the same, a focus on individual effort as a method for overcoming adversity, and a belief in the existence of one right pedagogy that is best for all students (Causey et al., 2000; Gay, 2015). On the other hand, researchers have found personal multicultural experiences tend to be associated with more positive and nuanced understandings of equity and diversity for some PSTs (e.g., Causey et al., 2000; Pohan, 1996). And Morales-Doyle et al. (2021) found an "increased focus on developing their practice as a teacher was inextricably related to their evolving ideological commitments and sociopolitical understandings" (p. 57). These researchers posited that "the contradictions of US schools require all of us... to think and act strategically and in ways that consider local contexts, which sometimes means operating with our ideologies in pieces or sitting with discomfort, tensions, and contradictions" (p. 58).

Within preparation programs, researchers have found PSTs tend to be "receptive, or at least tolerant, of broad, general ideas about... awareness, sensitivity, and appreciation of cultural difference" (Gay, 2015, p. 445) with resistance emerging when empowerment and activism are discussed (Gay, 2010; Howard, 2010; Kitchen, 2005; Lee, 2005). Research on efforts to challenge this resistance suggests PSTs need meaningful, sustained experiences working with nondominant student populations, and critical self-examination of personal perspectives and biases (Lucas et al., 2015; Milner, 2006). In their review of 58 articles from 13 countries focusing on PST education and equity, Liao et al. (2022) found nine types of program effects on PSTs including raising awareness and examining assumptions, taking positions and developing commitments, deepening and

increasing knowledge about students and pedagogy, expanding emotional and cognitive learning skills, and engaging in equity-oriented practices. Researchers also found that becoming a teacher who engages in equitable practices and advocates for equity "is a complex and challenging process, and involves incremental and multiple layers of changes over time" (Liao et al., 2022, p. 12). Liao et al. noted that a few of the articles they reviewed reported negative or no effects on some of the PSTs studied, explaining this was due to a combination of personal, curricular, and programmatic factors including limited experiences with diversity prior to becoming a PST, short or compartmentalized coursework, and lack of support/guidance (Kang & Zinger, 2019; Kraehe & Brown, 2011; Tinkler & Tinkler, 2013). Liao et al. (2022) call for teacher educators to take an integrated approach to prepare teachers in courses, model equitable teaching, and provide PSTs with support through the process. In addition, Liao et al. recommend researchers engage in more longitudinal studies to better understand the influence of equity-oriented education programs on PSTs as they transition to classroom teaching.

With respect to aspects or components of educational equity for students, Gutiérrez (2002, 2007, 2009a, 2013a) proposed four dimensions—access, achievement, identity, and power, and some researchers have begun to use these dimensions to examine the thinking of PSTs and practicing teachers. For example, Max (2017) considered which dimensions of equity PSTs would identify in vignettes of instruction and found the access dimension was strongly associated with a vignette related to calculator use, whereas the power dimension was more often associated with a vignette focusing on mathematical discourse. As another example, Rubel (2017) studied three early-career teachers who excelled in the dimensions of access and achievement but were challenged by the dimensions of identity and power. These challenges were associated with a lack of knowledge about the students and communities, the need to be neutral on social issues, being unaware of sociopolitical issues within topics they were discussing, and assumptions that equity involved only dimensions of access and achievement.

Rubel's study points to the need to address identity and power in teacher preparation. This is also reflected in the work of Mintos et al. (2019) who examined opportunities to learn about equity across five US teacher education programs and found PSTs had more opportunities to learn about equity as it relates to access and achievement than to learn about equity as it relates to identity and power. Further, within-program opportunities for thinking about access/achievement versus identity/power were siloed in mathematics and general education courses, respectively, causing Mintos et al. to call for a more coordinated and coherent vision for implementing equity across program components. In this paper, we examine teacher education program influences on PSTs' thinking about identity and power and consider tensions and contradictions in PSTs' evolving understandings of equity. Our research question is *What aspects of equity and equitable teacher practice, related to issues of identity and power, are prominent in the minds of PSTs nearing completion of their education programs in the U.S. context?*

Conceptual framing

In both educational research and teacher education, *equity* is often juxtaposed with *equality* with the latter connoting sameness in treatment regardless of individual differences—"everyone will be regarded and treated in the same manner without focusing on specific needs and requirements" (Zhu, 2018, p. 770). In contrast, equity takes individual differences as a starting point and assumes (1) attention to bias is necessary as sameness in treatment, or in the experience of treatment, is not possible, and (2) difference in treatment is needed to achieve parity in educational opportunities and outcomes. Contemporary researchers working from an equity perspective typically take as an assumption the idea that "power relations exist in all interactions and relationships, [and] there is no neutrality in education and research" (Aguirre et al., 2017, p. 126).

To focus on multiple aspects of PSTs' thinking about equity, we adopt the conceptual framing of equity as four related dimensions—access, achievement, identity, and power (Gutiérrez, 2002, 2007, 2009b, 2013a) (Fig. 1).

Within Gutiérrez's framework, the access dimension considers resources available to students in terms of quality teachers, rigorous curriculum, use of technology, and a classroom environment that promotes learning. Access is generally the dimension most associated with equity by PSTs and teachers (Mintos et al., 2019). According to Gutiérrez, it is important to consider the achievement dimension as part of equity framing, given the economic and social consequences a lack of achievement has on the lives of marginalized students (e.g., higher paying jobs, prestige). Achievement includes, for example, course-taking patterns, standardized test scores, and participating in the mathematics pipeline.

Access and achievement constitute the dominant axis in the framework, while the other two dimensions (identity and power) form the critical axis. Gutiérrez explains that teachers who focus on the dominant axis prepare their students to "play the game," while teachers who focus on dimensions of the critical axis prepare their students to "change the game." "Nepantla" refers to a middle space in which tension, conflict, and evolution are experienced.

Fig. 1 The four dimensions of equity (reprinted with permission from Gutiérrez, 2009b)
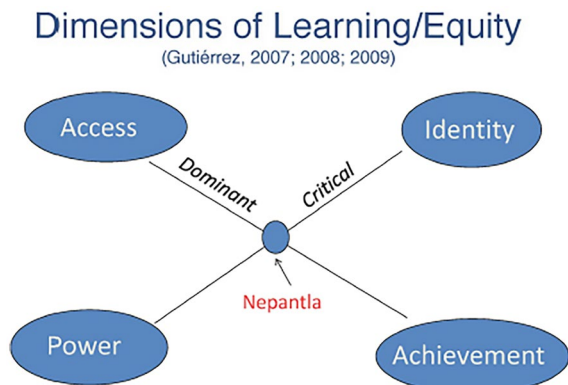
The identity dimension relates to the balance between self and others, how students are racialized, gendered, and classed, how they view themselves, and how they view and interact with others. According to Darragh (2016), "identity may be seen as an action and fit within a sociological frame or it may be seen as an acquisition, fitting within a psychological framing" (p. 19). We are concerned with both framings here, as PSTs describing their identity-related thinking about students may describe these as either something acquired and narrative, meaning the beliefs students express about themselves and the stories they tell about who they are in relation to mathematics, or participatory, meaning the ways students re-create and alter identity through participation in mathematical activities/classes (Graven & Heyd-Metzuyanim, 2019). We adopt as a definition of mathematical identity "the ways in which students think about themselves in relation to mathematics and the extent to which they have developed a commitment to, are engaged in, and see value in mathematics and in themselves as learners of mathematics" (Boaler & Selling, 2017, p. 82). Importantly, we are not studying the identities of PSTs themselves, but rather their ways of thinking about students' mathematical identities.

With regard to creating identity through participation, students should have opportunities to see themselves in the curriculum, to see the broader world, and to be encouraged to draw on their cultural and linguistic resources (e.g., algorithms learned in their home country, home language). They should see mathematics as useful to their lives, and have their mathematics valued in classrooms. And PSTs should learn "how identities are (re)constructed in spaces and moments" (Gutierrez, 2013a, p. 39) and the critical role they have to play in this process.

With respect to the power dimension, Gutiérrez posits that without it we preserve the status quo. Power involves social transformation at multiple levels including students having a voice in classrooms, using mathematics to critique society, engaging with alternative notions of knowledge, and reframing mathematics as a humanistic enterprise. Power is closely tied to identity as "individual's identity is partly in [their] …control and partly in the hands of others who seek to define/create/act themselves" (Gutiérrez, 2013a, p. 45). Power relations are continually re-constructed in classrooms, which creates opportunities for teachers to work with students to alter these relationships in ways that promote equity. Importantly, "a focus on identity and power is appropriate for understanding and improving the conditions not just for marginalized students, but for all students." (Gutiérrez, 2013a, p.49).

Methods

This report is part of a larger, longitudinal study examining the development of equity-related knowledge, beliefs, and practices of teachers who participated in one of five teacher preparation/education programs in the USA. In this section of the paper, we describe briefly the US educational context, the two teacher preparation programs and PSTs who are the focus of this report, and our data collection and analysis methodologies.

The US context

The teaching profession for students ages 5 to 18 in the USA is largely characterized by low pay, overwork, and political pressures, and it has seen a drop of over one third from 2008 to 2019 with respect to PST completion of university/college-based preparation programs, with mathematics as one of the areas of greatest decline (King & Weadé, 2022). In addition, although 55% of students in public schools (meaning tax-funded schools with elected leaders and open admissions within geographical districts) do not identify as White, 71% of those completing preparation programs identify as White (King & Weadé, 2022), resulting in a lack of representation that negatively impacts students (Grissom et al., 2015). Also, socio-economic status and tertiary education are strongly correlated with race and ethnicity in the USA. For example, individuals whose parents were not tertiary-educated are 10 times less likely to be tertiary-educated themselves as compared to those with tertiary-educated parents; by comparison, in New Zealand and Canada, individuals are 3 times and 4 times less likely, respectively (OECD, 2018).

With respect to the US education reforms in mathematics, Martin (2019) noted mathematics reforms have been framed to serve competitive economic and/or nationalistic and militaristic agendas rather than in liberatory terms, and "the forms of inclusion offered up in equity-oriented discourses and reforms have typically involved two trajectories: (1) inclusion accompanied by marginalization and (2) assimilation into existing cultures of mathematics education" (Martin, 2019, p. 460). Martin, writing particularly about anti-Blackness in the USA, proposes principled refusal as an appropriate and necessary response to systems of oppression and calls for students (and parents/caregivers) to "demand humane treatment and forms of mathematics education that help them fight against white supremacy, anti-blackness, and USA empire" (Martin, 2019, p. 472). At the same time as calls such as Martin's are being made for resistance, liberation, and justice, the US context is also characterized by leaders holding opposing viewpoints, and calling for and initiating actions to reduce or remove materials from classrooms that inform and/or engage students in learning about historic and present inequities in the world around them (e.g., Balingit, 2022). This, then, is the current context across large areas of the USA, as well as in the particular states and local-area school districts in which PSTs in this study are situated.

The teacher education programs

In this paper, we focus on two programs and 33 PSTs—19 from a university in the East USA and 14 from a university in the West USA (see Appendix A for demographic and program information). Grade 6–8 (ages 10–14) PSTs from the university in the East opt for two concentrations in their program, one of which is mathematics. Along with general education courses, PSTs complete four content courses in mathematics, a methods course, a diversity course, and a special education course. Grade 9–12 (ages 14–18) PSTs from the East complete a major

in mathematics and a minor in education. The minor consists of similar general education courses to those in the Grades 6–8 focus.

The PSTs from the West complete a mathematics major with a minor in ages 10–18 (Grades 6–12) education. In addition to general education courses, they also complete a course focused on curriculum and assessment, a course focused on methods of teaching mathematics, and a course focused on teaching diverse learners. All PSTs from the East and West universities complete clinical hours in schools as part of their programs and complete their student teaching (meaning full-time teaching with the support of a mentor teacher) in the last semester of their programs.

In addition to the program components previously described, all 19 PSTs from the East program were part of program funded by the US government and meant to encourage science, technology, engineering, and maths (STEM) majors to become grade 6–12 (ages 10–18 years) teachers in exchange for funding and an enriched program in their last 2 years of attendance at the university. As part of this program, PSTs attended a monthly seminar focused on culturally responsive teaching (Gay, 2010). Activities included evaluating and designing culturally responsive mathematics lessons using the Culturally Responsive Mathematics Teaching (CRMT) tool (Aguirre & Zavala, 2013), completing in-depth student interviews (Foote et al., 2015), and book readings—e.g., *Reading and Writing the World with Mathematics* (Gutstein, 2012) and *How to be an Antiracist* (Kendi, 2019). PSTs also spent time in a mentor teacher's classroom where they worked closely with two or three students assigned by the teacher.

The majority of West PSTs (11 of 14) were also part of a separate US government-funded program seeking to recruit, retain, and prepare STEM majors to become grade 6–12 (ages 10–18) teachers in exchange for funding for their last 2 years and an enriched program. As part of the program, these PSTs attended monthly seminars with invited speakers (e.g., teacher leaders, researchers, informal learning educators, community leaders) who led interactive sessions focused on issues of equity with connections to teaching mathematics. Session topics included complex instruction (Featherstone et al., 2011; Horn, 2013; Jilk, 2016), culturally responsive teaching (Gay, 2002, 2010), and equity literacy (Gorski, 2014; Gorski & Swalwell, 2015) among others. Equity literacy is based on the idea that educators must understand not only students' backgrounds and cultures, but also how to identify and work against inequity in their spheres of influence (Gorski, 2014). Seminar topics were woven into PSTs' undergraduate methods courses and clinical experiences to better connect theory and practice in their work with culturally and linguistically diverse students ages 10–18. In response to the COVID-19 pandemic, both seminars and methods courses were conducted online and drew upon rehumanizing approaches to mathematics teaching and learning as it related to equity and online teaching (Jessup et al., 2020, 2021; Wolfe, 2021, 2022).

In both programs, because of the pandemic, PSTs had varied clinical and student teaching experiences with a range of online, hybrid (rooming and zooming simultaneously), and in-person contexts, as well as experiences with unpredictable shifts in modality. The pandemic negatively impacted PSTs' opportunities to work with students and amplified long-standing systemic inequities related to access

including Internet/wifi connectivity, access to laptops/computers, and other social/physical resources.

Data collection and analysis

The study reported here passed an ethical review and informed consent was sought and obtained from PSTs. We use pseudonyms for PSTs and specific locations and names of particular programs are not reported. In addition to PST interviews, which are focal data sources for this report, we also collected program artifacts including course syllabi, assignments, and selected student work, and artifacts from the two US government-funded programs.

All 33 PSTs participated in a structured interview near the end of their programs in which they were asked to identify impactful aspects of the programs, knowledge, and experiences related to the equity they had gained, and actions teachers should take to promote equity (see Appendix B for interview prompts). The first two prompts were deliberately designed not to reference equity in order to investigate whether PSTs would describe equity, or equity-related ideas, as central to their program experiences and learning. We asked "How do you feel personally about equity?" and "What do you wonder... about equity...?" as ways to potentially elicit PSTs' thinking beyond or in contrast to what they had been taught in their programs. In addition, because some of the researchers were instructors in the PSTs' programs, we did not interview students whom we had taught, or who knew us as advisors/mentors. Lastly, we decided not to define equity in the interview prompts or during the interview but rather attempt to elicit from PSTs their definitions of equity through their descriptions of program experiences and their ways of describing the idea. Interviews were intended to be 45–60 min in length but varied widely between just over 20 min and just under 2.5 h, with both a mean and median interview length of approximately 55 minutes.

Interviews were transcribed, verified, and uploaded into qualitative analysis software for coding. To begin, we used an open-coding process (Strauss & Corbin, 1990) involving four interviews and two independent coders which resulted in a set of codes. Next, three researchers coded one common interview independently using the set of codes and met to discuss differences, refine coding categories, and add new codes as appropriate. Finally, three researchers independently coded three interviews each using the refined coding scheme and met to compare/refine codes. The final coding scheme we established accounted for the sections of data we interpreted as equity-related, with some sections of text receiving two or more codes. Using the process just described, we achieved kappas of 0.9^+ across coders for each code.

Having established interrater reliability, we then divided the set of interviews and applied the set of codes independently, meeting periodically and engaging in some common coding to ensure we had not individually begun to drift in our application of the codes. Codes we focused particularly on for the next stage of coding were those related to actions teachers could or should take to promote equity. Two researchers independently used conceptual coding (Saldaña, 2021) to create units of analysis at the level of action or idea about equity and then met to compare codes and achieve commonality.

Finally, four researchers used Gutierrez's dimensions of equity (Gutiérrez, 2002, 2007, 2009b, 2012, 2013a) as an organizational and interpretative lens through which to view this data. In this paper, we focus on three codes centered on action teachers should take to promote equity and describe the variety of ways PSTs thought about equity and their relative emphases, particularly as they relate to the dimensions of identity and power. In addition to this analysis, we also examined each interview for explicit associations PSTs made with program components (e.g., courses, field experiences, seminars, etc.) to better understand the influences of the programs on PSTs.

Limitations

Following Leatham (2006), we take PSTs' beliefs about equity and teaching as "sensible systems" and view as potentially problematic not belief systems themselves but rather PSTs' abilities to articulate their beliefs and our abilities to interpret their statements. A limitation of this study is that our interpretations depend on single interviews, coupled with our own personal knowledge of program emphases, materials, and components. A second limitation is that PSTs' belief systems around equity and teaching are developing, and thus, the study may demonstrate emerging thinking rather than well-formed and tested ideas. We attempted to interpret PSTs' use of terms such as "equity," "math identity," "active caring," "growth mindset," and "funds of knowledge" based on the descriptions and examples of the terms they provided; however, in cases where little or no descriptions/examples were provided, we could only consider use-of-term and not meaning.

Asking PSTs to report on program impacts and their views on equity raises the question of the extent to which they felt free to express their own thinking versus telling interviewers what they thought was expected. This issue intersected with the political climate in the USA at the time of the study and particularly the rise of "cancel culture." By cancel culture, we mean the shunning of individuals deemed to have spoken or acted in an unacceptable manner. We attempted to mitigate this issue by explicitly framing the interview to PSTs—"We are interested in hearing what you personally think... your ideas and opinions will help us to understand the value of program components and how to improve.... it is important that we hear what you truly think and feel." We also did not interview PSTs from our own programs and did not include equity in the first two interview prompts in order to examine which program components PSTs found most impactful and whether equity-related learning was among them. We did find some evidence in the data suggesting PSTs were expressing the effects of equity-related program instruction on themselves, rather than merely describing what the instruction was, including statements of personal transformation, statements questioning the concept of equity as it related to equality, statements expressing uncertainty, and statements connecting personal experiences as students in schools and universities to their program experiences. At the same time, we recognize as a limitation the likely desire of PSTs to demonstrate acceptable ways of talking about equity in the interview environment. We also recognize that perceived characteristics of interviewers (gender including pronouns visible on zoom, race, age) influence PSTs in terms of what they choose to say.

Results

The findings are divided into two sections—power and identity. In some instances, similar ideas can be found listed in both the power and identity sections, especially in the two associated appendices. This occurred when a teaching strategy described by a PST could serve purposes of supporting identity development and disrupting power hierarchies. In these cases, we were interested in the context surrounding the stated idea to determine the explicit intent, or at a minimum the implicit framing, of the PST, and whether their thinking was reflective of an identity or power focus.

Identity

With respect to identity, PSTs' descriptions clustered around three broad and overlapping categories: (1) building students' confidence and celebrating their success, (2) learning about and connecting aspects of instruction within classrooms to students' cultures and interests outside of school, and (3) attend to one's own thinking, biases, and mindset related to mathematics instruction and students (see Appendix C for a list of views expressed within these categories).

In the first subcategory, *building confidence and celebrating success*, we found aspects of teacher practice that could support creating classroom environments where mathematics ability myths are dispelled and a more positive mathematics identity is supported by valuing students' work, focusing on multiple ways of thinking, presenting differing solutions, and having a better understanding of the whole person (i.e., student) through active caring. In the second subcategory, *learn about and connect to students' interests/cultures*, we found a range of ideas from simply changing contexts of word problems to reflect interests (e.g., sports they play) to attending to students who may not connect to a problem context, to drawing on students' cultural funds of knowledge. In the third subcategory, *attend to bias and mindset*, some PSTs focused on anti-deficit mindsets, asset-based orientations to teaching, and ways judgments about perceived "surface behaviors" can promulgate inequity (e.g., removing a student from class). In the third category, we also noticed PSTs express thinking about judgments, prejudices, unconscious bias, reflection, and life-long learning, and an awareness of issues as systemic rather than about an individual person.

Building confidence and celebrating success

Many PSTs noted the importance of a classroom environment where students are engaged in tasks that connect with their interests and have multiple entry points and solution methods. According to these PSTs, teachers should value multiple approaches and dispel the myth that some people are good at mathematics (and others aren't) and that this is an innate trait. PSTs mentioned that teachers need to work at developing students' confidence, since students may not see themselves as capable. Some PSTs suggested focusing on students' progress as a method for improving the mathematical identities of students.

Alongside a focus on highlighting and celebrating students' mathematical progress, PSTs who focused attention on identity also tended to indicate "active caring" is essential, both to engage students and to sustain them through sometimes challenging content. For example, Denise (East) posited students want to know "[I know] you do this, this and this after school... I care and I'm gonna do what I can to help you.... I think that if they don't feel that they're gonna shut down and they're not gonna try."

Whereas some PSTs highlighted having honest and real relationships with students, others viewed relationships with students more as a stepping stone to better engagement. These PSTs described having a good relationship with your class overall as important for student motivation but did not focus on caring actively for the whole person. For these PSTs, the goal seemed to be more about getting students to care about class, as opposed to knowing and caring for individual students.

Learn about and connect to students' interests/cultures

Within this category, some PSTs highlighted the importance of understanding the role of students' cultures in class. Steven (West) said,

> I grew up in a, in a predominantly White, like 95% White, um, high school in a suburb (. . .) and seeing the, the different aspects in [West U.S. city] schools opened my eyes to, um, really the idea of having culture inside a classroom and of understanding a student's identity . . . or identifying prejudices, identifying color inside the classroom . . . understand how that plays a role . . . and then, um, advance it and allow it to be something that is accepted and praised.

Here, Steven recognized differences between himself and his students, and the need to understand and leverage students' cultures, especially those who are marginalized. This view of teaching then involves learning about students and their identities and contexts, in addition to knowing mathematical content. We also recognize in Steven's response a view of culture as something existing outside the borders of predominantly White schools, or at least as something he did not think about as a White student at a predominantly White school in the USA.

Also related to connecting to students' interests/cultures, we found a distinction across the data regarding the extent to which PSTs linked "interests" to "culture" or considered aspects of students' identities (e.g., poverty) when discussing connecting mathematics to students' interests/cultures. For example, Naomi (East) suggested shifting away from simple numerical word problems and towards "incorporating things like their interests into the problems that I'm giving them (. …) Oh, you're going to go shopping and you're going to have money or, um, points in a basketball game..." Naomi's statements reflect a view that students will be more engaged when mathematics is situated in a familiar context; however, the contexts Naomi (and some other PSTs in our data set) chose as examples provide evidence that their initial thoughts tend towards spending money and sports, and also towards dominant rather than marginalized student groups. Other PSTs, however, did describe students' funds of cultural or language knowledge as resources in their teaching,

such as something that can come from "their culture or their language or, um, like their experiences and that kind of, they kind of just have those things that you, as a teacher can use as a resource to... help them learn" (Kara, East).

Attend to bias and mindset

Fourteen PSTs described a myriad of foci and ways of thinking about this aspect of equitable practice. Taken together, we find an emphasis on how teachers view students (e.g., not judging, mitigating bias, maintaining an asset mindset) and on teacher reflection and lifelong learning. With respect to judgment and bias, Nina (East) noted the importance of "understanding your own bias and reflecting on it... like when you see students who are very chatty... I'm always like, oh, they just don't care but that's not the truth. Like they do really care and want to do well." Nina went further and suggested such students are actually "really smart." Other PSTs added that there are valid reasons why students behave the way they do, such as adolescent social/emotional/physical development.

Although many PSTs described strategies they could use as classroom teachers to address inequities and support the development of positive mathematical identities, other PSTs expressed tentativeness in openly discussing identity, and some expressed concerns around fairness in relation to differential treatment of students—"it could be bad if there's too much equity... singling out certain students and not being fair to all students" (Marley, West), or even denial of racial biases— "I don't judge people based on how they look" (Les, East). Only 10 of the 33 PSTs mentioned race or ethnicity explicitly (using these words or naming a particular race/ethnicity); most PSTs used terms/phrases such as "diversity," "different backgrounds," "cultural background," "factors of life," and "privileging one group". And when students did mention race explicitly, and if their own experience was as a White student in a predominantly White school/community, PSTs tended to associate their own background with both privilege and lack of culture. Overall, we see evidence within the interviews of PSTs' assumptions about Whiteness that echo the universalism (a supposed non-cultural experience is a universal experience) and individualism (believing a White person does not belong to a racially socialized group) described by DiAngelo (2011, 2018) and others (e.g., Evans-Winters & Hines, 2020; Matias, 2016).

We also found evidence that deficit views persist among PSTs. The ubiquitous image of two people looking over a fence with one person standing on boxes was mentioned frequently, but PSTs rarely interrogated the underlying deficit perspective (e.g., by questioning the existence or meaning of the fence or whether the ground is level). And for some PSTs, equity seemed to be only for "those students who have a harder time in class or have a harder time having access to the same resources as their peers" (Beatriz, West) or only for certain schools/districts—"I grew up in a school where... there wasn't much diversity, so equity wasn't a big issue. The teachers treated everyone equally rather than equitable" (Bella, West). We also found evidence that learning about students' circumstances, which is important for equitable practice, translated to deficit views and assumptions about families, such as

the belief that families needing older children to help out during the day means that "the parents don't even care enough for their education" (Melissa, West). Overall, we found PSTs' descriptions of equity and equitable practices demonstrated both knowledge and teaching potential in the identity dimension while at the same time reflecting the very ways of thinking (or not thinking) about race/ethnicity and socio-economic status that the programs were attempting to ameliorate.

Program influences

A review of interview data focusing on explicit connections made by PSTs to program components revealed future teachers often entered their programs focused on how best to present mathematics to students. But, through a combination of coursework, clinical field experiences, and participation in the US government-funded programs, PSTs gradually shifted their focus more toward learning about students and their lived experiences and building relationships with them.

Nine of 14 West program PSTs described the importance of building relationships with students and that this was something they had learned through their program. Program components cited by PSTs as associated with this learning varied and included coursework, clinical field experiences, US government-funded program seminars, and teaching opportunities. PSTs tended to express building relationships with students as fundamental and central to successful teaching—"the relationship you want with your students is more important than sometimes the math behind everything" (Melissa, West). PSTs sometimes went as far as to express building relationships as a necessity, something without which learning would not occur. And some PSTs juxtaposed their own prior negative experiences with mathematics with more positive experiences they had been afforded in their teacher preparation programs. Specifically, these PSTs described how their program instructors had shown them flexibility and understanding related to modes of learning, and assignment structures and deadlines, and they expressed a desire to provide similar experiences for their future students.

In contrast, East program PSTs were less likely to explicitly connect program experiences with a focus on building relationships with students, but were more likely to associate learning about equity specifically with their experiences in the US government-funded program in which they used the CRMT (Aguirre & Zavala, 2013) (mentioned by 5 of 19 PSTs) and considered methods for incorporating social justice into mathematics teaching (mentioned by 5 of 19 PSTs). Overall, 10 of 19 East PSTs explicitly linked their learning about equity to the US government-funded program and/or its main components. When East PSTs discussed building relationships with students, this tended to be associated with experiences shadowing and interviewing a small number of students, which was also a component of the same program. However, due to the pandemic, not all East PSTs were able to have this experience.

In addition to analyzing interviews for explicit connections to program components, we also considered specifically PST responses to the first two interview prompts: *Since you began your teacher education program at [institution], what*

experiences have particularly impacted how you think about teaching mathematics? What are some of the most important things you have learned about teaching and about students in your teacher education program? These prompts asked specifically about programs and not specifically about equity. In the East program, 11 of 19 PSTs referenced equity or an aspect of it (e.g., culturally responsive teaching, mathematics identity, social justice), and in the West program, 9 of 14 PSTs referenced equity or an aspect of it. East PSTs tended to reference culturally responsive teaching and social justice, while West PSTs tended to reference student identity. These findings are not surprising given the differences in program foci and materials; for example, culturally responsive teaching and social justice-related materials in the East (e.g., Aguirre & Zavala, 2013; Gutstein, 2012) versus mathematical identity-related material in the West (e.g., Aguirre et al., 2013; Boaler, 2016).

Power

Regarding the power dimension of equity, PSTs' ideas clustered into two categories, one focusing on status and assigning competence and the other focused on social justice (see Appendix D for a list of views expressed).

Use power to assign competence and/or alter hierarchies of competence/power

With respect to assigning competence and disrupting hierarchies of competence, PSTs' thinking reflected a sense of unfairness operating at a structural level and that teachers can/should disrupt structures. We juxtapose this with the identity dimension, in which PSTs focused more on encouraging participation by individual students or across students within current power structures. Some PSTs framed their thinking explicitly in terms of power, status, and/or assigning competence, while others described the idea and purpose without using these terms. PSTs in the second subcategory described ideas about teaching intended to support students in learning how to use mathematics to learn about the world and take actions. This can be juxtaposed with the identity subcategory "connect to students' interests/cultures" which focuses on bringing aspects of the world and particularly students' lives/experiences into classrooms to improve mathematics learning and make it more meaningful.

Emphasis in this part of the power dimension was concentrated on assigning competence and distributing power. For these PSTs, the concern seemed not (only) to be about access and identity, but also about something structurally amiss in classroom participation patterns. To address the problem, PSTs suggested various approaches tied to their programs—Poll Everywhere, randomly selecting a student solution on Desmos, using a clipboard to keep track of who had and had not participated, and assigning competence. For example, Frank (West) realized he would only call on the loudest students in class and allow them to dominate participation. After learning about equitable methods for grouping students and facilitating groupwork (Cohen & Lotan, 2014; Liljedahl, 2021), and after trying the strategies in his class, he highlighted how the approach disrupts hierarchies of competence and leads to more equitable classroom participation. Frank added,

[T]his kind of teaching, this group work building on students' strengths and giving them that public specific praise in class to raise their status of not only of themselves, but also how other students view them in class, I think, is it just, it does a lot for when it comes to equitable participation in class, you see students grow, you see them finally feeling like they have a voice.

While some PSTs, including Frank, framed their thinking in terms of "raising status" and "growth/voice," other PSTs focused on balancing "the over participators versus the under participators" which we also interpreted as focusing on restructuring participation in more equitable ways. We should note that some PSTs saw lowering the level of demand as a valid strategy for encouraging participation to alter status—"Even your most struggling students, you can give them a basic question just so they feel like they are a part of the class" (David, East).

Within the power dimension, some PSTs advocated for shifting power to students over how and with whom they work, including allowing students to choose whether to work in a group or alone. It is clear from the data that these PSTs' goal was to share some of their decision-making power with students; it is not clear from the data whether they are also considering ways such strategies can create/worsen inequities.

Engage students in using mathematics to critically analyze the world

With respect to using mathematics to critically analyze the world, PSTs noted the importance of discussing complex real-world situations with students. After working with examples at their universities, PSTs believed real-world issues could be integrated into mathematics lessons. Denise (East) said,

Something else that's really valuable that we've done in [our program] is the culturally responsive mathematics teaching rubric (. …) And we use that to, um, evaluate both our own lesson plans and the lesson plans of our peers. And also we use it in the creation of lesson plans. . . . I've really learned a lot from that . . . how to write a social justice lesson plan and what that should include and how to make sure that in doing that I don't lose any of the rigorous math[s].

Although Denise and other PSTs expressed the possibility of maintaining focus and rigor both in terms of mathematics and social justice issues, some PSTs were uncertain and cited concerns such as (1) time constraints given expectations to cover a large amount of mathematical content in a limited amount of time, (2) maturity of students to engage in (some of the) potential social justice topics, and (3) reactions of parents. One PST, Gina (East), brought up the possibility that some topics could affect students personally and could be traumatizing; citing her own experience with gentrification as a poor child growing up in a US city. Gina also exhibited an awareness of systems and structures in education that create or worsen inequity, such as schools focusing on disciplinary actions for students rather than root causes of behavior which may be structural/systemic.

Despite challenges noted by PSTs in integrating social justice topics in mathematics, a few PSTs indicated it was important to discuss challenging issues with students, including younger ones. Trinity (East), for example, mentioned that when the US Capitol building was attacked on January 6, 2021, she discussed the event with her middle grade (ages 10–14) students. She explained,

> [W]hen I was in middle school, I didn't feel like we were considered to be the future. Like our voice didn't really matter. And I want them, well, my students right now to understand that their voice matters . . . you should be aware of what's going on in the world to not wait till you get to 18. And then I feel like a lot of times we think when you get to be 18, they should already know all this stuff, but you actually have to build onto it.

Trinity's desire to empower her students aligns with the work of Gutstein (2006) in his middle grades classroom. Gutstein (2006) engaged his students in using mathematics within contexts such as gentrification and wealth distribution. In the process, students developed a better understanding of both mathematics and the contexts. Importantly, Gutstein (2012) was used as reading material in the program in the East. Although Trinity did not elaborate on how she may bring mathematics to bear on a discussion of social issues, she clearly demonstrated a vision of engaging younger students in learning "their voice matters."

Program influences

We found a clear split in the power dimension across the two programs. In the East, PSTs' experiences in their program included a focus on social justice through the use of materials such as *Reading and Writing the World with Mathematics* (Gutstein, 2012). These PSTs were much more likely than the West program PSTs to discuss bringing topics and activities into classrooms focused specifically on issues of social justice (e.g., food availability and quality, gentrification, policing). Compared to the East program, the West program focused more on complex instruction and assigning competence (Horn, 2013; Jilk, 2016; Smith & Stein, 2018), and mathematical mindsets (Boaler, 2016). And because one of the program course instructors was also leading teacher professional development in the local area focusing on complex instruction, some PSTs had the opportunity to visit and work in classrooms in which complex instruction was being implemented and observe the effects of group roles and assigning competence. In these cases, there was some consistency in language and perspectives between these PSTs' university work and their clinical experiences in schools that seemed to amplify the impact of experiences on PSTs. At the same time, PSTs noted when they did not have these opportunities—"I'm going through this rigorous programming... this is how you teach it, this is how you are going to do it.... it's kind of like, I'm ready to run but there's no road" (Andres, West). Such comments were found particularly among PSTs who had had their clinical experiences disrupted by COVID as schools shifted to remote instruction.

Discussion

The influence of personal experiences on PSTs' thinking about equity was an important theme in the data. PSTs often described their own lack of opportunities/support, or privileged circumstances, in relation to their thinking about equity and teaching. When PSTs identified themselves as privileged, they tended to view the experiences of others from a deficit perspective. In fact, deficit perspectives persisted in the ways many PSTs defined equity, and deficit perspectives existed alongside descriptions of the importance of attending to biases, mathematical identities, and power structures. At the same time, PSTs generally rejected the notion of fairness as sameness, and the majority of PSTs mentioned the importance of knowing about students' lives beyond the classroom, both for the purpose of providing support/resources and for bringing aspects of students' lives into classrooms and into mathematics. Overall, PSTs seem to have developed an understanding that teaching mathematics is not neutral, and one needs to consider particular students and their communities and backgrounds in teaching. We conjecture this importance may have become more visible to those PSTs in the study who had experiences teaching remotely or in a hybrid format during the pandemic.

Researchers have found PSTs (1) are more receptive to ideas about equity that relate to "awareness, sensitivity, and appreciation of cultural difference" (Gay, 2015, p. 445) than to ideas that relate to empowerment and activism (Gay, 2010; Howard, 2010; Kitchen, 2005; Lee, 2005), (2) have more opportunities to learn about access/achievement than identity/power (Mintos et al., 2019), (3) do not necessarily focus on student identity (Max, 2017), and (4) may ultimately be challenged as teachers by the identity and power dimensions of equity (Rubel, 2017). Our findings are somewhat, but not entirely, consistent with those of these researchers. Attention to issues along the identity dimensions was widespread in our data with PSTs in the West program tending to describe aspects of identity even before equity was explicitly mentioned in the interviews. And twenty-one of the 33 PSTs described an idea related to power. Several PSTs explicitly described encouraging student action and voice; however, these were the exception rather than the rule. Certainly, our research is consistent with prior work as it relates to resistance to the promotion of student activism by teachers.

Research on efforts to counter resistance to more critical aspects of equity work suggests self-examination of personal perspectives and biases is necessary (Lucas et al., 2015; Milner, 2006). Within this study, we found many examples of PSTs engaging in such reflections. We are currently following these students into their first 2 years of teaching, as we seek to better understand if/how critical self-examination is incorporated into their ongoing teacher practice.

Six of 33 PSTs raised concerns about the impracticality of equitable instruction. Of these six, some seemed to envision classrooms in which instruction needs to be modified for each student, rather than planned and structured in such a way as to be inclusive and open to different learners from the onset. Other PSTs were more concerned about expectations placed on teachers related to preparing students for

high-stakes testing, a feature of public schools across the USA, as well as expectations from parents and school leaders related to how and what they should teach. These concerns are also likely tied to the current political context in the USA. We recognize these concerns as valid and likely not well-enough addressed in either the East or West programs.

Caring about students beyond their performance on mathematics problems was a common theme across the data, with PSTs differing in self-described purposes for their caring. Some PSTs mainly focused on caring for the purpose of providing support (e.g., knowing if a student is hungry, knowing and considering out-of-school responsibilities), while others focused on building trust and relationships to motivate students to participate and learn. A few PSTs posited that authentic caring was essential or students would not engage and learn. On the other hand, a few PSTs describe the need to care in a way that suggests it might be an acted-out strategy to encourage engagement, rather than an attempt to develop a genuine relationship. This finding aligns with the work of Krall (2018) who found teachers mainly engaged in passive, rather than active, caring. According to Krall "Active caring demands a two-way relationship independent of the student's academic dispositions. Students who don't demonstrate a preternatural appreciation for the subject receive the same level of personal and cultural care as those who do" (pg. 42). In our case, we found evidence in the data that PSTs were thinking about both active and passive caring, with some PSTs focusing primarily on one or the other, and some describing aspects of both in their interviews.

Considering all four dimensions of equity, we did find a larger number of codes for both programs under the access dimension of equity. The prominence of the access dimension is consistent with other researchers, who have found PSTs are most comfortable thinking about access on the dominant axis (Mintos et al., 2019).

Implications

In the East and West programs, the most impactful learning about equity seemed to occur when PSTs had consistency in experiences within a subprogram (the US government-funded program in the East) or across courses and teaching experiences (West program). This is consistent with the findings of other researchers (e.g., Liao et al., 2022); however, it is worth emphasizing here as deficit perspectives of nondominant student groups have been found in studies across many countries (e.g., Averill & Rimoni, 2019; Flanagan, 2018; Maimane, 2014). In our own data, we found deficit views expressed by PSTs and sometimes these views seemed to exist alongside descriptions of implicit biases and the importance of viewing students as capable and knowledgeable. As we follow these PSTs into their first years of teaching, we will be interested to see how their experiences with students impact their thinking. Under what circumstances will deficit views give way to strengths-based teaching, under what circumstances will they become more deeply ingrained, and in what ways do they continue to co-exist?

We found Gutierrez's framework useful for unpacking the interview data and better understanding ways in which the two teacher education programs influenced PST

thinking on the dominant and critical axes. We posit the framework may be useful to mathematics teacher educators in a variety of political and educational contexts as they consider elements of their programs and curricula and critically examine their own practices as well as the myriad of ways PSTs can come to think about identity and power. As we conducted this research, we found ourselves interrogating our own assumptions and understanding of aspects of identity and power in the U.S. context (e.g., the assumed normativity of Whiteness) as well as various aspects of our teacher education programs. Reflecting on dominant ideologies and the ways research can uphold or challenge systems of oppression is an important work that has implications across contexts.

Appendix A

Table 1 Research participants' demographic data and grade level focus

University	Number of PSTs	Gender (self-identified)	Race (self-identified)	Program type
University in East USA	19	12 Females 7 Males	14 White 1 Asian 2 Black 1 Multiracial 1 Hispanic	Two programs Grades 6–8 (ages 10–14) 11 participants Grades 9–12 (ages 14–18) 8 participants
University in West USA	14	7 Females 4 Males 1 Non-binary 2 Not identified	10 White 3 Hispanic 1 Not identified	One program Grades 6–12 (ages 10–18) 14 participants

Appendix B

Interview prompts.

- Since you began your teacher education program at [institution], what experiences have particularly impacted how you think about teaching mathematics?
- What are some of the most important things you have learned about teaching and about students in your teacher education program?
- What, if any, instruction or experiences related to equity have you had in your teacher education program?
- What have you learned about equity through your teacher education program?
- How do you feel personally about equity?
- What actions should math[s] teachers take to promote equity in opportunities to learn, participation in learning, and learning outcomes?
- What do you wonder about, or what questions do you have, about equity and mathematics teaching?

Appendix C

Pre-service teachers' views on equitable Mathematics instruction related to identity.
  Build confidence and celebrate success (19 PSTs).

  Dispel mathematical ability myths, promote a growth mindset.
  Value work, multiple ways of thinking, different solutions.
  Create an environment for success, celebrate success.
  Use names and revoicing to build community.
  Understand mental health needs and be flexible.
  Engage in active caring—learn about and attend to the student as a whole person.

  Learn about and connect to students' interests/cultures (18 PSTs).

  Use students' interests as contexts for word problems.
  Get students to discuss where they see mathematics in their lives.
  Draw on students' funds of knowledge from their language and culture.
  Attend to whether all students have prior knowledge of a given real-world context.
  Be aware of hidden identities that impact students (e.g., poverty, documentation status).
  Use your own identity as a role model for students.
  Ensure representation of students' race and culture in the classroom (e.g., wall posters) and in the mathematics itself

  Attend to bias and mindset (14 PSTs).

  Approach students with an asset mindset

    Anti-deficit mindset (teacher) is important for a positive mathematics identity (student).
    Build the mathematics using student thinking/ideas, including incorrect ideas.

  Be careful of judgments based on surface behaviors

    Watch for stereotypes in one's thinking and cultural biases.
    Separate behavior from mathematical capability in your own mind.
    Understand the brain/body development of adolescents as it relates to student behavior.

  Understand and reflect on your biases, take action and continue to learn

    Identify your prejudices and the forms they take in the classroom (e.g., who tends to get viewed as a mathematician).
    Be a reflective practitioner and a life-long learner around equity (and in general).
    Avoid unconscious bias (e.g., use a random number generator to select students, use Desmos to gather up and display ideas and avoid calling on individuals).
    Be careful—some actions (e.g., using gender binaries in speech) harm students.
    Do not view a systemic issue as an issue with a person.
    Don't judge students by comparing them to other students.

Appendix D

Pre-service teachers' views on equitable Mathematics instruction related to power.

Use power to assign competence and/or alter the hierarchies of competence/power (16 PSTs).

Attend to the voices of marginalized students when setting up norms/procedures

Attend to status issues during group work

Use strategies to more fairly distribute participation (e.g., Complex Instruction, think–pair-share)

Ask students if they mind sharing, give them time to prepare and choose how to share, and create different ways that students can participate and communicate

Shift power to students over how and with whom they work

Orient the classroom away from a "cis-gendered, White, heteronormative space"

Engage students in using mathematics to critically analyze the world (10 PSTs).

Develop mathematical knowledge and knowledge of the world together.

Students can and should develop knowledge of the world and build their voice

Students can use real-world situations/data to make decisions and take actions beyond the classroom

Empower students to not be fooled by misleading data or data representations

Know your students, be careful of potential trauma given different personal experiences around a real-world topic (e.g., gentrification)

Show students ways that they can make an impact beyond the classroom

Declarations

Ethical approval The research study that underpins this publication was provided by The University of Arizona, Registration number 1712143884.

Informed consent Informed consent was obtained from all research subjects under The University of Arizona, Registration number 1712143884.

Conflict of interests The authors declare no competing interests.

References

Aguirre, J., Herbel-Eisenmann, B., Celedón-Pattichis, S., Civil, M., Wilkerson, T., Stephan, M., Pape, S., & Clements, D. H. (2017). Equity within mathematics education research as a political act: moving from choice to intentional collective professional responsibility. *Journal for Research in Mathematics Education, 48*(2), 124–147. https://doi-org.ezproxy2.library.arizona.edu/10.5951/jresematheduc.48.2.0124

Aguirre, J. M., & Zavala, M. R. (2013). Making culturally responsive mathematics teaching explicit: a lesson analysis tool. *Pedagogies: An International Journal*, *8*(2), 163–190. https://doi.org/10.1080/1554480X.2013.768518

Aguirre, J. M., Mayfield-Ingram, K., & Martin, D. B. (2013). *The impact of identity in K-8 mathematics: rethinking equity-based practices.* National Council of Teachers of Mathematics.

Association of Mathematics Teacher Educators. (2017). *Standards for preparing teachers of mathematics*. https://amte.net/standards

Australian Institute for Teaching and School Leadership. (2022). *Teacher standards*. https://www.aitsl.edu.au/standards

Averill, R. & Rimoni, F. (2019). Policy for enhancing Pasifika learner achievement in New Zealand: supports and challenges. *Linhas Críticas*, *25*, 41–56. https://doi.org/10.26512/lc.v25.2019.23780

Balingit, M. (2022, May 9). DeSantis accused textbooks of 'indoctrination.' Here's what he meant. *The Washington Post*. https://www.washingtonpost.com/education/2022/05/09/florida-banned-textbooks-math-desantis/

Boaler, J. (2016). *Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages and innovative teaching*. Jossey-Bass.

Boaler, J., & Selling, S. K. (2017). Psychological imprisonment or intellectual freedom? A longitudinal study of contrasting school mathematics approaches and their impact on adults' lives. *Journal for Research in Mathematics Education*, *48*(1), 78–105. https://doi.org/10.5951/jresematheduc.48.1.0078.

Causey, V. E., Thomas, C. D., & Armento, B. J. (2000). "Cultural diversity basically is a foreign term to me": The challenges of diversity for preservice education. *Teaching and Teacher Education, 16*(1), 33–45. https://doi.org/10.1016/S0742-051X(99)00039-6

Cohen, E., & Lotan, R. (2014). *Designing groupwork: strategies for the heterogeneous classroom* (3rd ed.). Teachers College Press.

Darragh, L. (2016). Identity research in mathematics education. *Educational Studies in Mathematics, 93*(1), 19–33. https://doi.org/10.1007/s10649-016-9696-5

DiAngelo, R. (2011). White fragility. *The International Journal of Critical Pedagogy*, *3*(3). 54–70. https://libjournal.uncg.edu/ijcp/article/view/249/116

DiAngelo, R. (2018). *White fragility: Why it's so hard for white people to talk about racism*. Beacon Press.

Draper, K., Hofmeyr, J., & Johnston, A. (2017). *Teacher professional standards for South Africa*. The Center for Development and Enterprise. https://www.cde.org.za/teacher-professional-standards-for-south-africa-the-road-to-better-performance-development-and-accountability/

Education Council New Zealand. (2011). *Tātaiako: cultural competencies for teachers of Māori learners.* https://teachingcouncil.nz/resource-centre/tataiako-cultural-competencies-for-teachers-of-maori-learners/

Evans-Winters, V. E., & Hines, D. E. (2020). Unmasking white fragility: How whiteness and white student resistance impacts anti-racist education. *Whiteness and Education, 5*(1), 1–16. https://doi.org/10.1080/23793406.2019.1675182

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.

Flanagan, A. (2018). *Teachers' expectations vary: implications for Canadian students of different ethnic groups*. [unpublished masters thesis]. University of Alberta.

Foote, M. Q., Roth McDuffie, A., Aguirre, J., Turner, E. E., Drake, C. & Bartell, T. G. (2015). Mathematics learning case study module. In C. Drake et al. (Eds.), *TeachMath Learning Modules for K-8 Mathematics Methods Courses*. Teachers Empowered to Advance Change in Mathematics Project. Retrieved from: http://www.teachmath.info

Gamoran, A., & Hannigan, E. (2000). Algebra for everyone? Benefits of college-preparatory mathematics for students with diverse abilities in early secondary school. *Educational Evaluation and Policy Analysis, 22*(3), 241–254. https://doi.org/10.3102/01623737022003241

Gay, G. (2002). Preparing for culturally responsive teaching. *Journal of Teacher Education, 53*(2), 106–116. https://doi.org/10.1177/0022487102053002003

Gay, G. (2010). *Culturally responsive teaching: theory, research, and practice* (2nd ed.). Teachers College Press.

Gay, G. (2015). Teachers' beliefs about cultural diversity: Problems and possibilities. In H. Fives & M. G. Gill (Eds.), *International handbook of research on teachers' beliefs* (pp. 436–452). Routledge.

Gonzalez, N., Moll, L. C., & Amanti, C. (2005). Funds of knowledge: Theorizing practices in households, communities, and classrooms. *Routledge.* https://doi.org/10.4324/9781410613462

Gorski, P. C. (2014). *Reaching and teaching students in poverty: strategies for erasing the opportunity gap.* Teachers College Press.

Gorski, P. C., & Swalwell, K. (2015). Equity literacy for all. *Educational Leadership*, *7*(6), 34–40. https://www.ascd.org/el/articles/equity-literacy-for-all

Graven, M., & Heyd-Metzuyanim, E. (2019). Mathematics identity research: the state of the art and future directions. *ZDM: International Journal on Mathematics Education*, *51*, 361–377. https://doi.org/10.1007/s11858-019-01050-y

Grissom, J. A., Kern, E. C., & Rodriguez, L. A. (2015). The "representative bureaucracy" in education: Educator workforce diversity, policy outputs, and outcomes for disadvantaged students. *Educational Researcher, 44*(3), 185–192. https://doi.org/10.3102/0013189X15580102

Gutiérrez, R. (2002). Enabling the practice of mathematics teachers in context: Towards a new equity research agenda. *Mathematical Thinking and Learning, 4*(2–3), 145–187. https://doi.org/10.1207/S15327833MTL04023_4

Gutiérrez, R. (2007). Context matters: equity, success, and the future of mathematics education. In T. Lamberg, & L. R. Wiest (Eds.), *Proceedings of the 29th annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 1–18). Reno, NV: University of Nevada. http://www.pmena.org/pmenaproceedings/PMENA%2029%202007%20Proceedings.pdf

Gutiérrez, R. (2009a). Embracing the inherent tensions in teaching mathematics from an equity stance. *Democracy and Education, 18*(3), 9–16. https://doi.org/10.1207/S15327833MTL04023_4

Gutiérrez, R. (2009b). Framing equity: Helping students "play the game" and "change the game." *Teaching for Excellence and Equity in Mathematics, 1*(1), 4–8.

Gutiérrez, R. (2012). Context matters: how should we conceptualize equity in mathematics education? In: Herbel-Eisenmann, B., Choppin, J., Wagner, D., Pimm, D. (Eds.) *Equity in Discourse for Mathematics Education. Mathematics Education Library*, vol 55. Springer. https://doi.org/10.1007/978-94-007-2813-4_2

Gutiérrez, R. (2013a). The sociopolitical turn in mathematics education. *Journal for Research in Mathematics Education, 44*(1), 37–68. https://doi.org/10.5951/jresematheduc.44.1.0037

Gutiérrez, R. (2013b). Why (urban) mathematics teachers need political knowledge. *Journal of Urban Mathematics Education, 6*(2), 7–19.

Gutstein, E. (2006). "The real world as we have seen it": Latino/a parents' voices on teaching mathematics for social justice. *Mathematical Thinking and Learning, 8*(3), 331–358. https://doi.org/10.1207/s15327833mtl0803_7

Gutstein, E. (2012). Reading and writing the world with mathematics: Toward a pedagogy for social justice. *Routledge.* https://doi.org/10.4324/9780203112946

Horn, I. (2013). *Strength in numbers: collaborative learning in secondary mathematics*. Reston, VA: National Council of Teachers of Mathematics.

Houser, N. O., & Chevalier, M. (1995). Multicultural self-development in the pre-service classroom: Equity education for the dominant culture. *Equity & Excellence in Education, 28*(3), 5–13. https://doi.org/10.1080/1066568950280302

Howard, T. C. (2010). *Why race and culture matter in schools: closing the achievement gap in America's classrooms*. Teachers College Press.

Jessup, N., Wolfe, J. A., & Kalinec-Craig, C. (2021). Rehumanizing mathematics education and building community in online spaces. In K. Hollenbrands, R. Anderson, & K. Oliver (Eds.), *Online Learning in Mathematics Education. Research in Mathematics Education* (pp. 95—113). Springer, Cham. https://doi.org/10.1007/978-3-030-80230-1_5

Jessup, N., Wolfe, J. A., Udiani, O., & Kalinec-Craig (2020). Issues of equity when teaching and learning mathematics in a pandemic. *Mathematics Teacher: Learning and Teaching PK-12, 113*(10), e58—e59. https://doi.org/10.5951/MTLT.2020.0154

Jilk, L. M. (2016). Supporting teacher noticing of students' mathematical strengths. *Mathematics Teacher Educator, 4*(2), 188–199. https://doi.org/10.5951/mathteaceduc.4.2.0188

Kang, H., & Zinger, D. (2019). What do core practices offer in preparing novice science teachers for equitable instruction? *Science Education*, *103*(4), 823e853. https://doi.org/10.1002/sce.21507

Kendi, I. X. (2019). *How to be an antiracist*. One World.

King, J. E., & Weadé, J. (2022). *Colleges of education: a national portrait, second edition.* American Association of Colleges for Teacher Education. https://aacte.org/resources/research-reports-and-briefs/colleges-of-education-a-national-portraitv2/

Kitchen, R. S. (2005). Making equity and multiculturalism explicit to transform mathematics education. In A. J. Rodriguez & R. S. Kitchen (Eds.), *Preparing mathematics and science teachers for diverse classrooms* (pp. 33–60). Lawrence Erlbaum.

Kraehe, A. M., & Brown, K. D. (2011). Awakening teachers' capacities for social justice With/In arts-based inquiries. *Equity & Excellence in Education*, *44*(4), 488e511. https://doi.org/10.1080/10665684.2011.610682

Krall, G. (2018). *Necessary conditions: teaching secondary math with academic safety, quality tasks, and effective facilitation.* Stenhouse.

Leatham, K. R. (2006). Viewing mathematics teachers' beliefs as sensible systems. *Journal of Mathematics Teacher Education*, *9*(1), 91–102. https://doi-org.ezproxy1.library.arizona.edu/10.1007/s10857-006-9006-8

Lee, S. (2005). *Up against whiteness: race, school, and immigrant youth.* Teachers College Press.

Liao, W., Wang, C., Zhou, J., Cui, Z., Sun, X., Bo, Y., Xu, M., & Dang, Q. (2022). The effects of equity-oriented teacher education on preservice teachers: A systematic review. *Teaching and Teacher Education, 119*, 1–15. https://doi.org/10.1016/j.tate.2022.103844

Liljedahl, P. (2021). *Building thinking classrooms in mathematics grades K-12: 14 teaching practices for enhancing learning.* Corwin.

Lucas, T., Villegas, A. M., & Martin, A. D. (2015). Teachers' beliefs about cultural diversity: Problems and possibilities. In H. Fives & M. G. Gill (Eds.), *International handbook of research on teachers' beliefs* (pp. 453–474). Routledge.

Maimane, J. R. (2014). South African Black learners' perceptions of their mathematics teachers. *Mediterranean Journal of Social Sciences, 5*(27), 522–528.

Martin, D. B. (2015). The collective Black and principles to actions. *Journal of Urban Mathematics Education*, *8*(1), 17–23. https://doi.org/10.21423/jume-v8i1a270

Martin, D. B. (2019). Equity, inclusion, and anti-blackness in mathematics education. *Race Ethnicity and Education, 22*(4), 459–478. https://doi.org/10.1080/13324.2019.1592833

Matias, C. E. (2016). *Feeling white: Whiteness, emotionality, and education.* Sense Publishers.

Max, B. (2017). Preservice secondary mathematics teachers' conceptualizations of equity: Access and power as seen through vignette responses. *School Science and Mathematics, 117*(7–8), 286–294. https://doi.org/10.1111/ssm.12246

McFarland, J., Hussar, B., de Brey, C., Snyder, T., Wang, X., Wilkinson-Flicker, S., Gebrekristos, S., Zhang, J., Rathbun, A., Barmer, A., Bullock Mann, F., & Hinz, S. (2017). *Condition of Education 2017* (NCES 2017- 144). U.S. Department of Education. National Center for Education Statistics.

Meaney, T., Trinick, T., & Fairhall, U. (2013). One size does NOT fit all: Achieving equity in Māori mathematics classrooms. *Journal for Research in Mathematics Education, 44*(1), 235–263. https://doi.org/10.5951/jresematheduc.44.1.0235

Miller, J., & Armour, D. (2021). Supporting successful outcomes in mathematics for Aboriginal and Torres Strait Islander students: A systematic review. *Asia-Pacific Journal of Teacher Education, 49*(1), 61–77. https://doi.org/10.1080/1359866X.2019.1698711

Milner, H. R. (2006). Preservice teachers' learning about cultural and racial diversity: Implications for urban education. *Urban Education, 41*(4), 343–375. https://doi.org/10.1177/0042085906289709

Mintos, A., Hoffman, A. J., Kersey, E., Newton, J., & Smith, D. (2019). Learning about issues of equity in secondary mathematics teacher education programs. *Journal of Mathematics Teacher Education, 22*, 433–458. https://doi.org/10.1007/s10857-018-9398-2

Morales-Doyle, D., Varelas, M., Segura, D., & Bernal-Munera, M. (2021). Access, dissent, ethics, and politics: Pre-service teachers negotiating conceptions of the work of teaching science for equity. *Cognition and Instruction, 39*(1), 35–64. https://doi.org/10.1080/07370008.2020.1828421

Moses, R. P., & Cobb, C. E. (2001). *Radical equations: civil rights from Mississippi to the algebra project.* Beacon Press.

National Council for Teacher Education. (2009). *The national curriculum framework for teacher education: Towards preparing professional and humane teachers.* https://ncte.gov.in/website/PDF/NCFTE_2009.pdf

Organisation for Economic Co-operation and Development. (2018). *Equity in education: Breaking down barriers to social mobility, PISA.* OECD Publishing. https://doi.org/10.1787/9789264073234-en

Pohan, C. A. (1996). Preservice teachers' beliefs about diversity: Uncovering factors leading to multicultural responsiveness. *Equity & Excellence in Education, 29*(3), 62–69. https://doi.org/10.1080/1066568960290310

Roberts, S. A. (2009). Supporting English language learners' development of mathematical literacy. *Democracy & Education, 18*(3), 29–36.

Rubel, L. H. (2017). Equity-directed instructional practices: beyond the dominant perspective. *Journal of Urban Mathematics Education*, *10*(2), 66–105. https://doi.org/10.21423/jume-v10i2a324

Saldaña, J. (2021). *The coding manual for qualitative researchers*. Sage. http://digital.casalini.it/9781529755992

Schofield, J. W. (2010). The colorblind perspective in school: causes and consequences. In J. A. Banks & A. C. Banks (Eds.), *Multicultural education: Issues and perspectives* (7th ed., pp. 259–283). Wiley.

Smith, M. S., & Stein, M. K. (2018). *5 practices for orchestrating productive mathematics discussions* (2nd ed.). Corwin.

Strauss, A. L., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory*. Sage Publications.

Strutchens, M., Bay-Williams, J., Civil, M., Chval, K., Malloy, C. E., White, D. Y., D'Ambrosio, B., & Berry, R. Q. (2012). Foregrounding equity in mathematics teacher education. *Journal of Mathematics Teacher Education, 15*(1), 1–7. https://doi.org/10.1007/s10857-011-9202-z

Tate, W. F. (1995). School mathematics and African American students: thinking seriously about opportunity-to-learn standards. *Educational Administration Quarterly*, *31*(3), 424–448. https://doi.org/10.1177/0013161X95031003006

The South African Council for Educators. (2020). *Professional teaching standards*. https://www.sace.org.za/assets/documents/uploads/sace_31561-2020-10-12-Professional%20Teaching%20Standards%20Brochure.pdf

Tinkler, B., & Tinkler, A. (2013). Experiencing the other: the impact of service-learning on preservice teachers' perceptions of diversity. *Teacher Education Quarterly*, *40*(4), 41e62. https://doi.org/10.1177/2F0022487113494845

Turner, H., Rubie-Davies, C. M., & Webber, M. (2015). Teacher expectations, ethnicity and the achievement gap. *New Zealand Journal of Educational Studies, 50*, 55–69. https://doi.org/10.1007/s40841-015-0004-1

Wager, A. A. (2012). Incorporating out-of-school mathematics: From cultural context to embedded practice. *Journal of Mathematics Teacher Education, 15*(1), 9–23. https://doi.org/10.1007/s10857-011-9199-3

Wolfe, J. A. (2021). A journey in becoming. *Mathematics Teacher: Learning and Teaching PK-2, 3*(114). https://doi.org/10.5951/MTLT.2020.0378

Wolfe, J. A. (2022). Building caring communities in math methods: COVID and classrooms in teacher education. In M. Shoffner & A. Webb (Eds.), *Care after COVID: Reconstructing understandings of care in teacher education* (pp. 104–114). Routledge.

Zhu, Y. (2018). Equity in mathematics education: what did TIMSS and PISA tell us in the last two decades? In G. Kaiser, H. Forgasz, M. Graven, A. Kuzniak, E. Simmt, & B. Xu (Eds.). *Invited Lectures from the 13th International Congress on Mathematical Education* (p. 769–786). Hamburg: Springer. https://link.springer.com/book/10.1007/978-3-319-72170-5