BLURRING BOUNDARIES WITHIN MATHEMATICS EDUCATION: PROSPECTIVE K-8 TEACHERS INTERROGATING INTERSECTIONAL IDENTITIES, NARRATIVES, AND POSITIONINGS IN OUT-OF-SCHOOL CONTEXTS

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ABSTRACT

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Mathematics teacher noticing as a pedagogical practice—attending to, interpreting, and responding to children's mathematical thinking—is growing within mathematics education communities. Much of the research literature primarily focuses on supporting teacher noticing of children's mathematical thinking within classroom contexts, such as analyzing classroom artifacts and video recordings. Recent efforts to support teachers make connections between mathematics and children's funds of knowledge, however, often involve professional work outside of classrooms where teachers learn about children's lived experiences and communities. While there is a growing expectation that teachers draw on children's funds of knowledge to support mathematics learning, this kind of professional work requires an ability to notice mathematics in out-of-school contexts.

The bulk of this dissertation is written as a series of three interconnected papers from a single qualitative study where I explored activities of a working group I facilitated to support prospective K-8 teachers to notice children's mathematical practices in out-of-school contexts. A primary thread across this work involves blurring boundaries within mathematics education. In my first article (pp. 51–76), I provided an overview of boundary blurring that prospective teachers in this study engaged—between mathematics and people as well as between mathematics and other disciplines—through early field experiences in out-of-school contexts. I zoomed in to examine a specific boundary, women and mathematics, in my second article (pp.

83–105) and explored intersections of gender, age, and elementary mathematics during an interaction at a science museum site visit. Then, in my third article (pp. 110–133), I zoomed out to focus on broader discourses within mathematics education to challenge overly simplistic all-or-nothing type stories about mathematics and people (e.g., 'being a math person').

Across my three articles, I engage an overarching question: What stories do prospective teachers tell about themselves, about children, and about mathematics? This study contributes to a collection of stories about prospective teachers' learning to notice children and their mathematical practices with implications for supporting mathematics teacher education, particularly in contexts outside of school. In closing, I share how my work connects to a broader project in mathematics education, *blurring boundaries*. I pose an underlying question for my continued work: What would it take to decolonize mathematics education?

To all the dreamers who used to play pretend before being told to “Wake up.”
To all the resisters, afraid and unafraid, who repeatedly refuse to be controlled.
To my family who endlessly provided their unconditional love.
To Jeff, my philosopher partner-in-crime; we found love in a hopeless place.

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I get by with a little help from my friends,

Get high with a little help from my friends,

Gonna try with a little help from my friends.

--The Beatles, "With a Little Help from My Friends" (Lennon & McCartney, 1967)

I do not know how to start this section; I have much gratitude to many people during this journey. First, I want to thank my family, Mama, Tata, and Lizann: for being so supportive during these last nine years that I decided to live across the country; for always calling, even when I didn't want to talk; and for always trying to share words of wisdom to make sure I do not harden and give up on the world.

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INTRODUCTION

and when we speak we are afraid
our words will not be heard
nor welcomed
but when we are silent
we are still afraid

So it is better to speak
remembering
we were never meant to survive.

--Audre Lorde, "A Litany for Survival"

Fighting back tears, Tyler[1] continued with his work—manipulating numbers and letters with arithmetic operations—occasionally thinking aloud with his steps. Why did future elementary teachers need to prove their fluency with old school algebra word problems? I knew Tyler was feeling frustrated. I recognized that pain, one that haunted my thoughts in abstract mathematics classes, telling me I was not good enough. Not 'mathy' enough to belong here. I thought back to a few weeks prior when Tyler told me that algebra was content that turned him off to mathematics, stating, "my brain just does not work that way." I wondered: is mathematics education ever going to change so future educators and students like Tyler can feel more fully human in mathematics spaces?

I share this story from my first teaching experience as a teacher educator in a required mathematics content course for prospective K-8 teachers. My perspective on teaching and learning mathematics stems from my experiences with teachers and students who are not served by narrow perspectives on mathematics education. As a person who regularly interacts with teacher educators and university researchers, I have grown tired hearing (and am extremely critical of) comments from colleagues that elementary education students do not have strong

[1] Pseudonym

mathematical knowledge and generally do not care about teaching mathematics. As a mathematics teacher educator, I have had multiple interactions with prospective elementary teachers—including Tyler—that suggest otherwise. I become especially enraged when I encounter commentary about prospective elementary teachers that shames their mathematical deficiencies—a discursive move devaluing (often) young women without recognizing them as people who are already mathematical beings of worth.

The (re)circulators of these discourses might not have intended to attack the future educators I personally knew; however, their language certainly does operate to dehumanize prospective elementary teachers. While these discourses about elementary mathematics education contribute to harmful narratives that maintain elitism of/within mathematics, they also act as an accomplice to discourses that blame elementary educators for a range of issues in mathematics education. '*If only elementary school teachers knew more mathematics, did not hate mathematics, and were more confident with mathematics, we could have better mathematics students in later grades.*' I disagree; we—as teachers, researchers, teacher educators—are all implicated. My scholarship, therefore, is grounded in and framed by identity and power in mathematics education.

As a K-12 student, I successfully navigated school mathematics without any genuine relationship to mathematics that allowed me to see it as beautiful, useful, or humanizing. Thus, I hold a Bachelor's degree in mathematics, yet do not voluntarily identify as a 'math person.' In fact, I am quite resistant to that label. I have spent years trying to make sense of my complicated relationship with mathematics as a discipline. I ultimately view my experiences as navigating the

borderlands[2] of mathematics education: I reject the consuming power of a 'math' label imposed onto my identity, but in doing so I feel judged on my presence in *mathematics* education spaces. How could I be in mathematics education if I am not a 'math person' like everyone else in this field? Of course, I reject a simplistic perspective that only 'math people' should be allowed to contribute to the field. I am caught in the middle of wanting mathematics (and mathematics education) to love me while I also learn to love myself as a holistic, complicated human who is shaped by other holistic, complicated humans and living beings in the world. Many times, I find this relationship with mathematics abusive; sometimes I am fulfilled.

From reflections on these experiences, I have come to approach my scholarship with the following guiding question: How will I work to deconstruct and reconstruct mathematics (education) in ways that treat students, teachers, and prospective teachers with dignity and love? I found this question especially vital as I grappled with our current post-election impacts.

> November 9, 2016, the day after Donald Trump won the United States Presidential Election, and I am literally struggling to *be*. I am numb and do not feel anything for longer than a few moments. I have felt this before; I recognize grief. As an avid social media contributor and consumer, I am troubled by all of the discourses immediately surrounding me: nonchalant, unsurprised expressions; calls to "move on" and let the four years pass; narratives invoking 'hope for the future' adjacent to images of a blue United States when looking at how millennials voted. What strange things to say. *How can I care about representation of women and people of color in STEM[3] fields when we are not considered fully human enough to matter in our white[4] supremacist cisheteropatriarchal*

[2] I draw from Gloria Anzaldúa's (1987) 'borderland' as "a vague and undetermined place created by the emotional residue of an unnatural boundary…a constant state of transition" (p. 25).

[3] Science, Technology, Engineering, and Mathematics

[4] I capitalize 'White' when I racialize a person and not when I use it as a descriptor for institutions (e.g., white supremacy, predominantly white institution).

> *society?* I struggled to find meaning in mathematics education as I thought about Latinx[5] children who were (and are still) taunted in schools by classmates chanting, "Build the wall!" and families who are overwhelmed with fear for their safety.
>
> WTF. People keep (re)circulating discourses that literally ignore colonization. Slavery, yes. Immigrants, yes. White supremacy, yes. Genocide and dominance to steal bodies and land? Long lists of "I stand with…" without mentioning Indigenous peoples? My people? "*We are a nation of immigrants*." What? I am losing my mind.
>
> [Journal Entry, 11/9/2016]

Being on fellowship funding this year, I had no formal teaching obligations and chose to stay at home far away from my predominantly white institution. My black and brown friends immediately organized healing spaces where we could share physical company, our tears, and love for one another. Hauntingly, I recognized remnants of grief we shared together in March 2016 after losing one of our own to addiction. I felt like I had aged years in the short span of 8 months. We often must organize ourselves because our university was always silent when it came to our needs as students of color; the best we would get were carefully crafted (and vetted) email statements about 'diversity and inclusion' and 'courageous and honest dialogue' a few days later.

Through those moments of togetherness, though, I was reminded of our collective strength in fighting for justice across multiple institutions. This work is never only for ourselves; it is built upon legacies of our ancestors and is continued for future generations. What might seem like small impacts on mathematics education are ultimately part of a much bigger

[5] I intentionally use 'Latinx' as gender-fair language and a sign of solidarity with people who do not identify with a narrow construction of gender as a binary of female/male. Additionally, I use this term as a form of resistance to patriarchy embedded in Spanish pronoun usage. I have much more to say about the complexities of my (multi)racial identity in connection to my language choice, but that conversation deserves a more extensive discussion than a footnote.

movement for liberation and humanity. My orientations toward fighting against inequities and injustices frame the way I live, including my pedagogy and intellectual ponderings.

Since the election, I have found myself stuck at times. The best way I can describe my stuckness is grounded in my anxiety—not feeling psychologically safe. For example, I visited Greece for an international conference and found myself overwhelmingly nervous whenever people would ask me and my colleagues where we were from. I was ashamed and apprehensive to say, "United States." Other times, I recognized my anxiety during what used to be mundane daily wanderings on my way to work, getting groceries, or spending leisurely time on social media. I would drive around and see Trump/Pence signs, taunting me with "Make America Great Again!" or "#trumptrain" messages. I would scroll down my virtual feeds filled with backlash against feminism and brutal critique against college student demands to be treated as fully human. I was drowning, suffocating, overwhelmed, every day a new paper cut from an apparently unavoidable density of domination and dehumanization.

I also often found myself considering mathematics education unimportant. I still slip in and out of this thinking. In turn, I have become more invested in multi- and trans-disciplinary work. This is also why I feel more comfortable living in the world of elementary education where people are more likely to foreground holistic care. Obviously, I can talk about the political context as a major part of the public discourse in situating *when* I am writing this dissertation; however, my choice to talk about the election and new administration extends beyond a temporal context. My intention is to foreground how I know the world through *more*[6] than a strictly mathematical lens.

[6] Invoking this kind of quantitative rhetoric is a discursive move that I am still trying to make sense of in my thinking. What I label as 'more' is not necessarily about quantity in an additive sense, but rather a complexity that I feel is often downplayed in research work.

My work in mathematics (teacher) education is not solely a product of my mathematical knowledge and development (despite messages about what my graduate program values), but rather how I exist in and navigate through our world. My geographical navigations for *where* I have written this work include: Lansing outside of formal school-related activities, East Lansing when I am on or near campus, wherever professional conferences are located (this year, Long Beach, Tucson, Orlando, Minneapolis, and cities in Greece), and multiple locations across the country for job interviews. I have written many pages in airports and on airplanes. I have also written this work in ways I might not be able to consciously articulate.

The way I know my work is through my whole self, not some segmented part or reconfigured version of myself that is solely mathematical. As Audre Lorde (1984) said,

> My fullest concentration of energy is available to me only when I integrate all the parts of who I am, openly, allowing power from particular sources of my living to flow back and forth freely through all my different selves, without the restrictions of externally imposed definition. Only then can I bring myself and my energies as a whole to the service of those struggles which I embrace as part of my living. (pp. 120–121)

I embrace my whole self—all that is simultaneously messy and dynamic—for my specific work in mathematics education and my broader project as a human existing in the world. I was not expecting to find resonance with the 2016 Presidential Election aftermath[7] for my work in mathematics education. In reflection, I suppose part of my surprise speaks to how normal it is to distance mathematics education from politics, even for someone who thinks a lot about identity and power. Writing through the election has been part of my healing.

Through my growth as an early-career scholar and philosopher, I believe each human being is constantly producing knowledge and is always engaged in learning activities. What

[7] For a comical representation of being a doctoral student during this aftermath see "Piled Higher and Deeper" by Jorge Cham, "Resolution": http://www.phdcomics.com/comics.php?f=1914

follows is that I am not interested in efforts to 'speed up' learning or to identify one 'best way' of learning mathematics. Thus, as an educator and scholar, I turn to study *discourse* as human creations that impact individuals, societies, and social structures.

I view discourses as in the air all the time; we constantly breathe them in and out (Aguirre, 2017). Deficit discourses, which speak to larger interlocking systems of oppression, create an atmosphere of violence (Bullock, 2017). Recognizing my agentive power, I am inspired to 'clean the air' by actively not participating in deficit discourses about prospective elementary teachers (and students) and instead speak back to these discourses by offering more humanizing framings. This is a deliberate ethical decision I choose to pursue as a scholar.

> Just as we need to detoxify to remove harmful toxic substances from our bodies due to manufactured and processed foods, we need "detoxification" to remove harmful words, ideas, convictions, and perceptions from our minds due to manufactured and processed knowledge. (Fasheh, 2015, p. 33)

Seeking 'detoxification' for my (and others') wellbeing, I pose the following questions for mathematics education researchers and teacher educators to ponder: What ethical considerations do we ignore if we continue to (re)circulate discourses that construct limiting predetermined identities of prospective teachers (and students)? Do we choose to contribute to toxic framings? How might we reconstruct?

Embracing My Positionality

> *La facultad* is the capacity to see in surface phenomena the meaning of deeper realities, to see the deep structure below the surface... Those who are pushed out of the tribe for being different are likely to become more sensitized (when not brutalized into insensitivity). Those who do not feel psychologically or physically safe in the world are more apt to develop this sense... It's a kind of survival tactic that people, caught between worlds, unknowingly cultivate. (Anzaldúa, 1987, pp. 60-61)

I take an interpretive stance in my work with commitments to equity and justice in mathematics education. My interpretations are shaped by my lived experiences as a Latinx woman who successfully navigated schooling structures and traditional mathematics classroom spaces. Additionally, my interpretations are continually shaped by my experiences as a mathematics teacher educator and researcher who navigates predominantly white institutions. Therefore, I foreground my own positionality as important in my data generation and analyses as a mathematics education researcher and in my critical self-reflections as an educator.

My professional work centers on issues of inequity with attention to identity and power in mathematics spaces, largely based on my lived experiences in schools. When I was five years old, I wanted to be a teacher; however, over the years in school I was constantly encouraged to pursue STEM-based careers instead because I was a Latinx girl who other people saw as 'good at math.' I participated in numerous outreach programs designed for 'underrepresented minority' students (i.e., women/girls and people of color) in STEM fields. No one encouraged me to go into education; 'they[8]' *needed* me in STEM. Now, I have some credentials to show off my mathematical achievements and capabilities, but none of that speaks to my stories of marginalization in mathematics spaces.

My current research agenda remains true to why I left a mathematics-based career trajectory. Identity and power have become fundamental in my work because that is why I am here as an educational researcher: my story (and many people's stories) is not told with integrity if we diminish or dismiss issues of identity and power within mathematics spaces. I think about

[8] Many are included in this 'they' for different reasons. Companies 'need' us to portray images of progressiveness and fairness. People of color 'need' us to have role model representation and to transform oppressive spaces. Outreach programs that receive grants 'need' us to justify funding (salaries) for their work. Researchers 'need' us for similar reasons. Our parents 'need' us to have better opportunities than they ever did. *But what do we want and need?*

how students (and teachers) do or do not see themselves as competent mathematical thinkers and doers and how these thoughts are so entangled with the gendered and racialized interactions that play out in mathematics spaces. Why do power, privilege, and oppression often go unacknowledged when we talk about mathematics teaching and learning? I aspire to be more like scholars in mathematics education who take on a sociopolitical lens in their work. Although some mathematics education researchers are talking about issues of inequity and social justice, my impression is that the field largely does not. I take on a sociopolitical lens and embrace my own positionality with Anzaldúa's concept of *la facultad*. I enter this space with a poem.

Accentuating as Political: The Drama of My Name

I have always hated feelings of permanence with publishing my work.
Printed words that cannot move with my dynamic self.
A continually unfinished creation;
rewritten with each breath.
Well, I put it off long enough: How do I write my name?

Middle initial as a 'professional' template (costume)
or full name to honor my parents' choices?
D-e-capital A-u-n.
Unlike my driver's license with all caps
or my student ID that ignores capitalizing the 'A,'
disobeying my mother's intentions.

Do I carve an accented 'a' in Guzmán?
Does that make me seem too foreign?
Too exotic?
Will people more readily make assumptions about me and my racial identity?
I guess they do that anyway.

What about my job applications?
More likely to look at me in service of 'diversity and inclusion'?
Interest convergence is real life. #SOML[9]
Will people be excited to have a brown Spanish-speaking colleague
and ultimately meet me with disappointment?
My r's do not roll.
I struggle with making vowels sound just right.

[9] Story Of My Life

Time to confront those racial complexities.
Hush that doubt; *I am enough.*
Yes. I must write that accent mark.
I will write my full name.
I deserve my full name.

For the countless mispronunciations:
GOOZ-mun,
GOOZ-man,
or the completely unrecognizable *GUHZ-man*.
I firmly correct, Gooz-MAHN
(you know, Spanish vowels: ah, eh, ee, oh, oo).
They respond with the same irritating mispronunciation
(as if *I* were the one wrong about my own name).
I must have forgotten my place.

What would I be able to imagine
if I didn't have to think about these things so often?
No longer afraid,
I stand tall with a jazz walk swagger;
all 5 foot 1 inch of height and sass.
I deserve my full name.[10]

My entire life I have been chastised for being too emotional. Growing up, my *tata*[11] would always say to me, "Don't be so emotional! Be a swan: calm on the surface and kicking like hell underneath." I frequently tried and failed at this advice; I like to wear my heart on my sleeve. In graduate school, this was often referred to as *minimizing my own bias*. Occasionally, I would be praised for my 'passion,' but even those times never felt like a full compliment. I always read these admonishments as gendered—intensified because of my existence as a woman—and consequently, I have spent much of my intellectual labor masking my emotions to not be viewed as a stereotypical over-emotional, over-reactive, irrational Latinx woman who has

[10] This poem is partially inspired by a spoken word performance called "My Name" by Yesika Salgado and Aman Batra (All Def Poetry, 2016).

[11] A colloquial Latin American (for my heritage, Mexican) term for 'father.'

clouded her judgement with feminist ideas. I have been socialized to act in ways that do not draw attention to my womanhood and my brownness.

Rather than continually suppressing an important part of my human self, I now embrace my emotionality as an asset for how I know and create in the world and follow researchers who foreground positionality in their scholarly work (e.g., Anzaldúa, 1987; D'Ambrosio et al., 2013; Milner, 2007). As Sonia Nieto once said to our MSU College of Education *Rueda Latin@*[12] group, "I believe we are writing and re-writing our autobiographies" through our scholarship (personal communication, September 28, 2016). Thus, my dissertation work is about stories, situated within social, political, and historical contexts (including my own stories and my lived experiences with mathematics and mathematics education). I have an emotional connection to my work, tethered by my values of building relationships and engaging in more humanizing approaches to research (Paris & Winn, 2014).

In writing my dissertation, I have spent much time working through writing a section about one prospective teacher in my study (Ann) and I visiting a children's science museum for a site visit to engage in teacher noticing of children's mathematical practices. I used positioning theory to unpack gendered and aged interactions we had with a museum volunteer who acted very condescending to us and dismissed our expertise as people who study elementary mathematics education. I brought transcription of this interaction to our working group, and we discussed sexist and ageist interpretations of what happened. I bring up this section because I have encountered much critique about my own bias in the data generation and analysis. Thus, I

[12] Rueda Latin@ was established by Latinx graduate students and faculty in the College of Education on February 14, 2014 and became an official student organization at MSU shortly thereafter. From our mission statement: "we recognized the need to support one another, validate and challenge each other's knowledge, and ensure the successful completion of our respective graduate programs in the College of Education."

identify the type of work in this chapter as an area of growth as a writer—to clarify the nuances in what I am saying and justifying why I do this work based on existing scholarship. We are all implicated by an *imperialist white supremacist capitalist patriarchy* in which we live (hooks, 2013), tainted with lived and living histories of colonialism and conquest.

I have become increasingly more aware of my own perspectives on the role of mathematics in education. Upon reflecting on my internal reactions to what I hear other people say, I think to myself, '*Wow. Am I really that radical?*' I suppose so, but at the same time, I do not think I am. According to Danny Martin, "radical agendas are not and should never be beholden to the dominant system" (Valoyes-Chávez, Martin, Spencer, Valero, & Chronaki, 2017), which is partly why at times I do not see myself as radical *enough*. Much of my work is done within the dominant system in which mathematics education operates.

When I talk about what I envision for mathematics education in schools, though, I am not talking about figuring out how to teach algebra better. Rather, I question why algebra is worth pursuing in mathematics education, and who wins and who loses during this effort? I *am* trying to imagine and engage possibilities for something radically different than what I and many others have experienced. Versions of mathematics education that center human beings as creators and dreamers. People as mathematical beings—not because we can attempt to quantify and measure our knowledge of formalized mathematical ideas in preparation for some future engagement with mathematical ideas, but because we *already are brilliant in mathematically complex ways* that are integrated with aspects of ourselves that have historically been dismissed as not mathematical.

One statement I want to make explicit is that I am not here to save anyone. The world is not burning *because of* problems within mathematics education. I believe problems within

societies, fueled by clashes among competing moral philosophies, infect the ways we do, think about, and talk about mathematics (and STEM) education. While I would like to foreground my work without invoking a metaphor of war, I am still in the process of learning how to reorient what I do in addressing injustices within education. At the same time, I find it difficult to let go of a war metaphor because I ultimately view my work as unapologetic resistance. I take up a role as a mathematics education researcher who tells stories that speak back to acts of violence—legacies of control, domination, and dehumanization—within mathematics education spaces. Mainstream problems we identify in mathematics education, though, are shrapnel. That is, I find it unlikely that mathematics education communities could 'solve' our problems without addressing legacies of control, domination, and dehumanization that exist 'outside' of mathematics education. This is the challenge (and fulfillment) of praxis.

As a teacher educator, I serve as an advocate for teachers, their learning, and most importantly, their students' learning. I encourage teachers to challenge assumptions, embrace complexities, learn from students, and strive to make mathematics classrooms more humane through their professional work (Aguirre, Mayfield-Ingram, & Martin, 2013). I want children (and all people) to be able to thrive as humans in the world. Currently, I see mathematics spaces largely operating in ways that separate and suppress people by narrow perspectives and values on difference.

Rather than emphasizing hierarchies such as 'better,' 'slower,' 'bad,' or 'advanced,' what if we relied on building communities and sharing our unique gifts and knowledges with each other? What if we, as educators, reclaimed schools as places where all children are uplifted for their creativity and compassion? For the meantime, I continue to integrate mathematics with students' lives and interests, but I have dreams of a more liberating culture for mathematics

education both in schools and outside of schools. For the sake of our humanity, we cannot afford to maintain mathematics as separate and distant from people and our world; we must reframe and reimagine better mathematics spaces.

Overview

The bulk of this dissertation is written as a series of three interconnected papers from a single qualitative study. I chose to preface each paper with an essay that situates a broader social, cultural, and political context and connects to my lived experiences and intellectual explorations. Although differing in tone and style, I do not intend to suggest that the content of each article should be separated from each corresponding essay with a distinct border. Rather, the connected essays are meant to represent the real tensions I experience as a scholar who spends much intellectual play time in spaces that are typically not considered 'academic' (e.g., YouTube, Twitter) and through reflecting on my own experiences as a human being continually learning 'to human[13]' in the world. Sometimes I am discouraged to cite such content as knowledge in 'academic' writing; however, I seek to blur boundaries that claim what constitutes knowledge during these interludes between my three research articles. I further expand on my thinking in Methodological Messiness (pp. 18–43) where I describe the methodological, philosophical, and epistemological complexities in my scholarship.

One of my intentions with each essay is to foreground how my "effort to understand others' understandings is mediated by [my] own professional, personal, and collective knowledge and experiences" (Dyson & Genishi, 2005, p. 82). I am inspired by many strong, brilliant people of color and their creative endeavors—to name a few: Cherríe Moraga and Gloria

[13] I pull this phrase from YouTuber Jenna Marbles (Mourey, 2016) who, in response to a fan question (*What is your meaning of life?*), stated, "I think for me, personally, the apex of being a human is teaching another human how to human," as important to how she viewed her life journey and fulfill part of her purpose in this world.

Anzaldúa's (1981) edited book, *This Bridge Called My Back: Writings by Radical Women of Color*; Beyoncé's (2016) visual album, *Lemonade*; and my TE 963 (Critical Race Theory in Education) colleagues[14] with whom I have co-produced a performance that speaks to our racialized experiences as graduate students of color navigating schooling structures.

I feel confident in my essay-style writing, and a primary reason I separated these essays from the articles is because I have not (yet) figured out how to integrate both texts (if I should at all). My hope is for readers to see this piece of my writerly journey in my dissertation. Additionally, I use these essays to provide a small window into Lynette DeAun Guzmán as a "primary instrument of research" (Dyson & Genishi, 2005, p. 58) who engages theoretical and intellectual work at home, across time and space, and through my body. I attempt to break the 'fourth wall' of this dissertation performance by sharing my stories[15] and thoughts that link to this work. I have oscillated between feelings of confidence and apprehension with this choice. Sometimes I am quite afraid to speak. But as Audre Lorde (1995) wrote in "A Litany for Survival,"

> when we are silent
> we are still afraid
> so it is better to speak
> remembering

[14] I am grateful to Aliya Beavers, Tashal Brown, Durrell Jones, Alba Isabel Lamar, and Vivek Vellanki for our intense intellectual and creative work in "Tracing Our Stories: Graduate Students of Color Reflect on Racialized Experiences through Political Autobiographies" (2017).

[15] Through the process of writing, I have paused multiple times in sharing my stories. I hesitate because these stories—especially ones that involve writing about other people—do not solely belong to me. Do I ever really have my own stories or are they always *our* stories…? Nonetheless, I tried my best to mask individual identities of people in my stories by carefully choosing labels that are meant to draw attention to my point. For example, I might include racial and gender identifiers to foreground these intersections in some stories but not others.

we were never meant to survive (p. 32).

Her words (among words from many others who are unafraid) give me strength and courage.

My first article, "'Math doesn't always have to be solving equations': Blurring Boundaries through Early Field Experiences in Out-of-School Contexts" (pp. 51–76), examines the potential for early field experiences to provide prospective elementary teachers opportunities to reframe conversations around children and their mathematical practices through blurring limiting boundaries constructed around mathematics. I highlight a collaboration among five K-8 prospective teachers in a working group that I facilitated focused on learning to notice children's mathematical practices across out-of-school contexts (e.g., children's garden, science museum). This work extends scholarship investigating mathematics teacher noticing by considering the following research question: In what ways do early field experiences in out-of-school contexts support prospective elementary teachers to develop new conceptions of children, mathematics, and mathematics education?

My second article, "Beyond Hidden Figures: Shining a Spotlight on Constructed Hierarchies of Gender, Age, and Elementary Mathematics" (pp. 83–105), centers on conversations about gender and mathematics among other intersecting identities such as age, education level, and professional expertise. In this article, I use positioning theory to unpack a conversation at a science museum (between museum volunteer John, prospective teacher Ann, and myself) to share a story about gender and mathematics. I argue that the impact of this conversation from our perspectives as young women who do work in elementary mathematics education should be made visible to recognize and address inequities for women and girls within mathematics and mathematics education spaces.

My third article, "Complex and Contradictory Conversations: Interrogating Dominant Narratives within Mathematics Education Discourse" (pp. 110–133), foregrounds my reflections

and learning as a mathematics teacher educator facilitating the working group context in this dissertation. In this article, I explore complex and contradictory conversations during an idea mapping task in which prospective elementary teachers interrogate dominant discourses within mathematics education, such as 'mathematics is everywhere' and 'being a math person.' I argue that this exercise engaging with contradictions in our own thinking provides prospective teachers opportunities to tease out nuances for articulating differences and reconstruct ideas that generate new perspectives for teaching and learning mathematics.

Across my three articles, I explore an overarching question: What stories do prospective teachers tell about themselves, about children, and about mathematics? This study contributes to a collection of stories about prospective teachers' learning to notice children and their mathematical practices with implications for supporting mathematics teacher education, particularly in contexts outside of school. In closing, I share how my work connects to a broader project in mathematics education, *blurring boundaries*. I pose an underlying question for my continued work: What would it take to decolonize mathematics education?

CHAPTER TWO:

METHODOLOGICAL MESSINESS

LYNETTE: I don't know. I don't have all the answers.

BETH: Yeah. And then you start to think, and you're like, '*Are these the right words?*'

[Group Meeting, 4/13/2016]

My work in this dissertation has been a long, complex process of shaping ideas through embodied sensemaking of the world during this point in my existence. Even still, I find myself molding my writing in specific ways, adhering (or censoring myself) to genres that exude 'professionalism' to suggest I am worthy of being called 'academic.' I have tried my best to work within a dissertation genre while staying genuine to my convictions and typical demeanor. I recognize that I might receive critique for some of my diction, but I maintain that this work is academic. In this section, I seek to uncover some of the methodological messiness that I do not foreground as much in the following three articles. Much of this messiness is intertwined with my positionality and my epistemological and philosophical orientations. I close this section with a more 'traditional' methods section for the larger dissertation project.

My perspective as a qualitative researcher is largely shaped by Paris & Winn's (2014) conceptualization of humanizing approaches, which "involve the building of relationships of care and dignity and dialogic consciousness raising for both researchers and participants" (p. xvi). Diaz-Strong, Luna-Duarte, Gómez, & Meiners (2014) foreground the emotional aspect of their work as researchers who were often "upset, depressed, and sad while trying to think and to write" about youth immigration experiences in the United States (p. 5). Outlining feelings of anger, frustration, and sadness resonated deeply with me. Although different contexts, thinking and writing about gender microaggressions and mathematics evoked similar intense emotions (see Chapter Four, pp. 77–105).

Microaggressions are harmful because they serve as constant, irritating reminders of dehumanization. Not only did I engage in "retracing some of the steps of a journey" (Ahmed, 2017, p. 11) from a personally painful experience—full of repeated interruptions and instances of invalidation—but also was reminded of all previous aggressions within mathematics spaces that made me leave my path to a mathematics-based career and enter this doctoral program in mathematics education. Every time I listened to the audiorecording, reread the transcript, wrote something down to defend why I am talking about this conversation, revised and reshaped that writing based on feedback that (at times) did not seem to care about our story, I felt echoes of lingering remnants from the past. I have experienced a strange freshness and fading of wounds. Recent assaults leave deep cuts that undergo a process of reopening and rehealing while scar tissue hardens.

In October 2015, I visited an estate sale with my partner. I found and bought a copy of Sonia Nieto's *Affirming Diversity: The Sociopolitical Context of Multicultural Education*. When I got home, I did not even get to read the first page because I found a letter in the book that appeared to be a memo written by a woman named Corinna (dated 9/15/1993). It was addressed to "All my friends and colleagues who are afraid that I may be moving in 'dangerous' directions with my dissertation" with the subject "Rejoinder." At the time, it was quite strange to find something that seemed so random (yet perfectly timed) from a person I did not (and most likely will never) know that resonated so powerfully with myself, my thoughts, and my feelings. Although I had many favorite parts in the letter, one that connected to the way I view my scholarship now is the following:

> I usually only share my deepest thoughts with those I know intimately, and maybe that is the way it should be, I really don't know. But if we are going to cross this great divide, is not the first step to really tell people who you are, what you think, and what you feel?

I have come to realize that navigating my feelings are central to my research work. Knowing what it is like to navigate the world in *my* body is important; "my anger has meant pain to me but it has also meant survival" (Lorde, 1984, p. 132). Completing this dissertation has been a giant magnifying glass on my own stories as connected to the stories of the women with whom I worked. I take a stance that "the personal is theoretical" (Ahmed, 2017, p. 10) and offer pieces of my personal theorizing as embedded in this work. I hope my vulnerability attracts resonance.

"I'm not crazy"[16]: Managing Gaslighting[17] Attempts

Part of finding solace in humanizing approaches to research comes from negotiating my feelings of not being 'enough' in multiple intersecting ways—my mathiness, Latinx-ness, toughness (emotionality), youth, teaching experiences. I have spent the last five years of my life constantly feeling out of place, like I do not truly belong anywhere. My only validation at times is when people share stories like mine. Through much deep reflection, I have identified three aspects of my identity that connect with my dissertation work: race, feminism, and age. While of course these identities intersect, I foregrounded each one separately in what follows. I share brief glimpses of each to provide a bit of context for my methodological decisions as a researcher, shaped by these perspectives through which I know the world.

[16] I do not remember exactly when I heard and took up this phrase, but I do know it was early in my doctoral program in a space with graduate students of color where we discussed our daily encounters with racism and dehumanization in our doctoral education. Gildersleeve, Croom, and Vasquez (2011) called this social narrative '*Am I going crazy?!*' "to represent the tentativeness, insecurity, and doubt that can be projected onto doctoral students of color" (p. 100).

[17] *Gaslighting* is "a form of emotional abuse where the abuser intentionally manipulates the physical environment or mental state of the abusee, and then deflects responsibility by provoking the abusee to think that the changes reside in their imagination, thus constituting a weakened perception of reality" (Roberts & Carter Andrews, 2013, p. 70). The term originates from Patrick Hamilton's *Gas Light* (1938), a British play about a man who used psychological manipulation to trick his wife to believe she was going insane.

On Race

I know that what I know is something to be known, something real, because other people's stories resonate with my stories. For example, *Borderlands/La Frontera* (Anzaldúa, 1987) was published two years before I was born, but the resonance I felt when reading it was powerful and nearly indescribable. It was incredible to read text that told pieces of my life—my racialized experiences, my relationship with Spanish and English (and Spanglish) languages—even before I existed in this world. How was that possible?

I am inspired by Chicana feminist scholars such as Gloria Anzaldúa, Cherríe Moraga, Sandra Cisneros, and Lindsay Pérez Huber. I am also inspired by brilliant women of color mathematics education researchers, Julia Aguirre, Rochelle Gutiérrez, Erika Bullock, Marta Civil, Sandra Crespo, Cynthia Anhalt, Maisie Gholson, Luz Maldonado, Nicole Joseph… the list goes on. Although these authors' words give me life, I am frustrated that I had not read their work earlier.

I was labeled an 'underrepresented minority' in mathematics spaces; this problem did not go away when I entered mathematics education spaces. One difference was that I did not hear many people talking about it until I read a book chapter by Julia Aguirre (2009):

> The low-level production of Latino/a mathematics educators with PhDs is sobering. According to the National Science Fondation (NSF), between 1994 and 2004, 39 out of 1,086 (3.5%) mathematics education doctorates were awarded to Latinos/as (NSF, 2006). I am one of these 39. On average over this decade, the number of Latino/a doctorates produced annually can be counted on one hand. (p. 295)

The first time I read these words was during my second year doctoral proseminar course, an overview of mathematics education research. I will never forget that this chapter was the piece of scholarship that made me believe I could do work in mathematics education research. Not only was this a person who looked like me, but she was also unapologetically speaking truth to power.

Unlike the previous mathematics education research work I had read in through my doctoral courses, I felt a genuinely deep connection.

I study scholars who push for a radical transformation of mathematics education by centering race. I admire and seek to emulate, but I also want to be different. Julia Aguirre recently shared a story with our MSU Rueda Latin@ group, ending with the question: *Are you Martin or Malcolm?* (personal communication, March 15, 2017). According to an online quiz[18] I am (currently) a Malcolm: "Some people may object to the ardor and strength with which you hold your convictions, but that same strength and confidence in your ideas is what makes you a good leader." I am often encouraged to be more like Martin, though.

As a woman of color scholar, I am critiqued regardless of how much I talk about race; I either talk about race too much or too little. It is an almost impossible space to navigate. I make an intentional (political) effort to cite women of color in my work. In previous writing feedback, I have been asked to make explicit how this 'move' citing women of color 'changes' my lens. Quite simply, it does not change my lens; it *is* my lens (one of many). Race and racialized experiences come in and out of focus in this dissertation.

On Feminism

I was a child of the 1990s. I used to play 'Spice Girls' with my friends, and we would constantly incant the mantra, *Girl Power!* Because there was no spice girl who looked like me, I was assigned as Ginger spice when we played. The '90s were filled with 'girl power' messages: a surge of female singer songwriters in pop music, Hermione Granger as a brilliant heroine in J.K. Rowling's *Harry Potter* series, and a popular 1997 Gatorade commercial with athletes Mia Hamm and Michael Jordan competing to outperform each other, set to the repeated lines,

[18] Quiz available at this website: https://www.buzzfeed.com/alexisnedd/are-you-more-martin-luther-king-jr-or-more-malcolm-x

"Anything you can do I can do better; I can do anything better than you." Along with these messages from the girl power feminist movement of the '90s, my parents also shaped my thinking about feminism by emphasizing that I could do *anything* I wanted and nothing should ever hold me back. Sometimes this intense emphasis becomes pressure, though, turning girls *can* do anything into girls *should* do everything.

As a woman of color, intersectional feminism is redundant because feminism must always be intersectional for us to matter. Feminist work has been a complicated space for me to navigate. I discuss part of this messiness in my essay, "Searching for Solidarity: Writing about Intersectional Gender Inequities in the Wake of the 2016 Presidential Election Aftermath" (pp. 77–82). In addition to barriers to solidarity, feminist work is often difficult to engage when there exists a strong blindness to feminist issues:

> When you become a feminist, you find out very quickly: what you aim to bring to an end some do not recognize as existing… So much feminist and antiracist work is the work of trying to convince others that sexism and racism have not ended; that sexism and racism are fundamental to the injustices of late capitalism; that they matter. Just to talk about sexism and racism here and now is to refuse displacement; it is to refuse to wrap your speech around postfeminism or postrace, which would require you to use the past tense (back then) or an elsewhere (over there).
>
> Even to describe something as sexist and racist here and now can get you into trouble. You point to structures; they say it is in your head. What you describe as material is dismissed as mental… (Ahmed, 2017, pp. 5-6)

Many times, I am exhausted. Drained. Anxious. Frustrated. Irritated. Apathetic. Somehow all at the same time and at all times. I gain life in my counterspaces. My self-care involves reading text that names and validates the reality of this work. Feminism is a primary focus of my second article and corresponding essay. It is also foundational to this research design and my choice to engage participatory research work.

On Age

I love being a millennial. I share a special bond with my generation—from our experiences as children growing up during the internet boom to dealing with the ways other generations love to bash us. For example, one tongue-in-cheek Buzzfeed post (Akbar & Regna, 2016) compiled a list of "28 things millennials are killing in cold blood," taken from headlines[19] such as 'Millennials are killing the napkin industry' and 'Millennials say American Dream is dead? They killed it.' While I would not mind shattering the American Dream myth, I know it is still alive and has not been killed by millennials. As for the napkin industry—viciously being killed by millennials who are opting for paper towels instead—I must admit that I do not understand why the napkin industry exists and why it should be maintained. As a millennial, I feel some type of way about this obsession with our generation—studying us, marketing to us, blaming us, infantilizing us—so I found the compilation post of headlines hilarious but also infuriating. It is also one primary reason I think about age so much in my work.

One day I was talking to my mom on the phone, and she was ranting about millennials at her workplace: they have no loyalty, they're too needy, they are too busy trying to 'find' themselves. I listened to her characterizations and replied, "You know I'm a millennial, right?"

"No! You're not a millennial, you're like, Generation X or something!"

"Nope, I am a millennial. All of these things you're saying could be said by somebody else about me!"

"No… you're not a millennial. You're not like *them*."

[19] The density of headlines using "Millennials are killing…" as a template has become a meme used to mock this trend of articles that blame millennials as the cause of harm to various industries in the United States.

I write about age (in terms of generations) because it matters to how I see the world and what is foregrounded in my perspective. It matters for the kinds of social positions other people offer to me through daily interactions. It matters because I am a millennial teacher educator who works with millennial prospective teachers, and I have a different shared understanding of the world through our generational experiences. It is different because when I hear colleagues complain about millennials and their terribly informal, self-centered selves, I hear them talking about me. They are talking about me. And what is different is that I make sense of our 'millennial' ways of being in the world as young people who are unafraid of constructed hierarchies, who seek meaning of this thing we call life, who are unimpressed with social reproduction that maintains inequities, who embrace alternative models of engagement, and who are not necessarily beholden to tradition for tradition's sake.

I applaud Gloria Ladson-Billings (2017) as one scholar who wrote about young people (and our generation) in a more humanizing way:

> Far too often we talk about our young people as consumed with frivolous pursuits—posting selfies or engaging in Twitter wars—or worse, totally apathetic to the world around them. But I believe this generation is engaged deeply in fighting for justice and equality. This is the generation that has taken to the streets to shout "Black Lives Matter." This is the generation that shimmied up a flagpole to remove a state sanctioned symbol of hatred and racism, the Confederate flag. This is a generation that is being shot down in the street just for being Black. This is a generation that realized that having an African American occupy the Oval Office would never be enough to bring the nation to the realization that Black people are fully human and entitled to all rights and responsibilities of citizenship in these United States. So on Wednesday, May 10, 2017 the graduates of Bethune Cookman University represented their generation well and took a stand!

I am a millennial, and I encourage writing (and thinking) about millennials with more complexity and care—with more attention to dignity and love. Preaching to prospective teachers

that they should not view their students in deficit framings is disingenuous if teacher educators view prospective teachers in deficit framings.

Knowing through Feeling

Resolving the tensions I feel in wanting to belong but not wanting to be labeled, I believe that we are all masterpieces continually in progress. In other words, I appreciate my current existence as an already whole human being, rather than a person who is preparing to become some future idealized self. Yet, I am also dynamic, which opens possibilities for change. 'In progress' does not mean I am working toward a static end goal; it means there is no end so I must embrace all of it. Most importantly, I do not hold this view only for myself—I believe each human being is just as complex as I see myself. That is why it is so difficult for me to make sense of acts seeking to dehumanize.

I often get asked '*How do you know?*' when it comes to experiencing microaggressions based on race, gender, or age in my daily life. I know while it is happening from much more than just spoken words: the tone, the gaze, the posture, the silence, and the vibes and energies I feel in the space. It is quite an embodied experience, sometimes indescribable. In my retellings of stories, though, many people have stared at me in disbelief that anyone would say such a thing or questioned how people could be so blatant with their racism and sexism. Sadly, I only share the stories that I *can* articulate in words; I would not be able to 'convincingly' share the stories where my only 'evidence' is non-verbal. Feeling is an important sense that tends to be the first dismissed in my experiences as a scholar (with requests for *stronger* evidence). Hierarchies seem inevitable; power is ever-present, establishing regimes of truth (Foucault, 1980).

Making the Familiar Strange: An Enterprise of Knowledge Production

I view myself as a deeply engaged dabbler. My theoretical perspectives are largely informed by postmodernism (Foucault, 1980; Valero, 2004), poststructuralism (St. Pierre & Pillow, 2000; Walshaw, 2001), feminist epistemologies (Ahmed, 2017; Anzaldúa, 1987; Collins, 2000; Lorde, 1984; Moraga & Anzaldúa, 1981), critical race theories (Crenshaw, 1991; Delgado & Stefancic, 2012; hooks, 2013; Ladson-Billings & Tate, 1995; Lorde, 1984; Taylor, Gillborn, & Ladson-Billings, 2016), and sociocultural theories (Lave & Wenger, 1991; Kelly, 2006).

The epigraph for this section points to my postmodern dabbling; I do not pretend to have all the answers. Like Beth, I also question whether I am using the 'right' words, not to seek a universal truth but rather to continually make the familiar strange in my work. Through my poststructural dabbling, I am encouraged by an agentive hope that "discourses are not closed systems and that shifts in historical thought and material conditions are possible" (St. Pierre & Pillow, 2000, p. 5). This is important to my work because it involves imagining visions for something different, even if the particularities are not yet articulable. My dabbling in critical race theories have provided a mirror to name what I see in my world. Critical race theories center relationships among race, racism, and power by centering lived experiences of people of color. I have gravitated to *testimonio* as a methodological approach to produce counternarratives that speak back to deficit framings (e.g., Pérez Huber & Cueva, 2012). Finally, my dabbling in sociocultural theories informs how I value educational spaces that center participation involving identity work while attending to situated discourses, norms, and practices.

I want to note that I do not agree with everything these scholars have ever written; I do not consider myself a disciple as part of a specific camp or team. Sometimes I feel my thinking within critical theories and postmodernism or poststructuralism are compatible (e.g., Stinson &

Bullock, 2012), even though I recognize there are contradictions within and across these theories. Sometimes I refuse to decenter myself as a subject. Sometimes I dislike theory, and sometimes I realize that what I previously labeled as 'not theory' could also be viewed as theory building. Sometimes I think I understand the world, and sometimes the world seems incomprehensible. Sometimes I recognize these dualities at the same time.

The closest label I can latch onto to describe my deeply engaged dabbling is *metamodernism*, which is a philosophical paradigm that negotiates modern and postmodern thoughts. Vermeulen and van den Akker (2010) described metamodernism as oscillation "between a modern enthusiasm and a postmodern irony, between hope and melancholy, between naïveté and knowingness, empathy and apathy, unity and plurality, totality and fragmentation, purity and ambiguity" (p. 2). These authors noted their resistance to a conceptualization of metamodernism as a philosophy following a system of thought, closed with boundaries. Instead, they offered metamodernism as a structure of feeling, which "is a sensibility that is widespread enough to be called structural… yet that cannot be reduced to one particular strategy" (Vermeulen & van den Akker, 2015). Although messy, I feel comforted by a seemingly contradictory and elusive characterization of metamodernism because it makes sense for how I exist—often oscillating between (or among) ideas and explanations for my many 'working theories' I privately ponder.

An example of a metamodern creation that has greatly influenced me during this dissertation journey is a YouTube series, *Don't Hug me I'm Scared*. Visually, the six-episode series appears to be a children's puppet show (like Sesame Street) that followed three main characters: a yellow humanoid puppet, a red stringy-haired creature, and a duck puppet. Each episode centered on a theme that the characters explored with 'teachers' they encountered in this

world. Episode one focused on creativity—while the main characters sat at a kitchen table, a notepad puppet broke the silence, singing, "What's your favorite idea? Mine is being creative" (Don't Hug Me .I'm Scared, 2011). The characters 'learned' about creativity from the notepad teacher, full of conflicting messages about what is (or is not) creative. For example, one popular line often cited by fans of this series is when the notepad 'evaluates' the yellow character's creative work, stating, "Green is not a creative color." As the episode continued, the visual surroundings and dialogue become increasingly more disturbing with fake organs, dissonant chords, and distorted images of the characters and surroundings. Subsequent episodes, each with different singing puppet teachers, cover topics on *time*, *love*, *computers*, *food*, and *dreams*.

This series has been quite popular on the internet; at the time of writing this section, the YouTube channel had over 1.4 million subscribers (of whom I am one) and collectively over 159 million views. I was introduced to the series through REACT, another one of my favorite YouTube channels, where YouTubers were asked to react to (and theorize about) the first episode as a viral video (Fine Brothers Entertainment, 2013). Since then, I have browsed numerous fan theories about the meaning of the series. I have also engaged in my own theorizing, which made me obsessed[20] with the series as a creative work. I believe the juxtaposition of singing puppets (and expectation of a happy children's television show) and explorations of big ideas about life, death, and reality engage a detached seriousness that metamoderism embodies. While an interpretation of the series might be a silly and strange

[20] I found the series before the final episode was published on the YouTube channel. Many fans speculated that the final episode would be released on June 19, 2016 because 'June 19' was the date on a wall calendar that was a common "Easter egg" visible in episodes. I waited for the episode to launch all day on June 19, 2016, constantly refreshing Twitter and YouTube. After finally watching the episode, I stayed on Twitter to see what other people thought about it on the #dhmis6 hashtag and later watched YouTuber theory videos about the whole series.

compilation of randomness, another simultaneous interpretation might be a jarring critique on modern societal structures. I find this fusion beautifully brilliant.

Politics of Knowledge Production

After Erika Bullock's (2017) plenary at the 9th international meeting of Mathematics Education and Society, one of the working groups reported out with questions from their debriefing discussion: *How is intersectionality new? What does it have to offer that we don't already know?* In that moment, I was livid and did not know why. I kept thinking about it and realized that I recognized this discursive move. You could replace *intersectionality* with anything else and still hear that question in many academic spaces. Was this another intellectual ploy[21], deployed to dismiss women of color scholars (whether intentionally or not)?

I must admit that I do not understand an obsession with 'new'-ness in knowledge production because it disregards that our knowledge is intimately linked with time, space, and people. Then, can we ever dismiss knowledge with critiques of 'new'-ness? New to whom? For whom? What does it mean 'to know' something? Am I only 'allowed' to claim knowledge if I can cite other scholars? Do I already know and produce knowledge through my body—continually navigating and making sense of my experiences with a mind-body connection? Can I know and produce knowledge through my being, regardless of whether I can articulate it? *Knowledge is political*. Knowledge and power are inseparable (Foucault, 1980).

I question the enterprise of academic research as a primary means for knowledge production. In this space, I chose to engage philosophical work. But the more dystopian novels I read, song lyrics I hear, and stand-up comedy acts I watch, the more I recognize that academia

[21] Neale (2015) wrote about standard intellectual ploys that are invoked to misdirect 'radical' academic work to maintain hierarchical functioning within academia. For example, a discipline ploy might be a statement like, '*That is interesting, but it is not my field (or not mathematics education).*' I currently make sense of '*Where's the math?*' as a discipline ploy.

does not own philosophical and theoretical practices. Writers, artists, comics (and more) produce knowledge and are philosophers. My parents produce knowledge and are philosophers. The prospective elementary teachers in this dissertation produce knowledge and are philosophers. They did not need PhDs to do so. I do not seek to wholly dismiss the work of scholars. Critical Race Theories, for example, provided me language and labels to talk about my racialized experiences and marginalization in school (Beavers et al., 2017; Guzmán, 2016). But I *already* knew from a young[22] age something about race and white supremacy. My means of articulation for knowledge production were not words; they were feelings. I take a strong stance that *feeling* is a legitimate way of knowing.

To be clear, I am not intending to demonize the role of playing in theoretical spaces as scholars, but I do wonder about my own positionality and ask myself how I intend to use it with whatever privilege and status I am afforded as an academic scholar. Sometimes when I am encapsulated in the theoretical world, I tend to abstract relationships among people, and consequently, maintain distance. Under some research methodologies and paradigms, this distancing might be desired as an indicator of validity. However, it is through these relationships and corresponding emotional connections that are part of how I make sense of the knowledge I strive to produce and the transformation that I hope to engage.

One major take-away from working through my methodological messiness is a continual recognition that we, as human beings, are complex and contradictory. We might struggle because our work is difficult. But a beautiful aspect of this work is embracing human connection: among ourselves as people in the world and in solidarity as people continually working toward a more

[22] In tracing our racialized stories (Beavers et al., 2017), one major theme across all six of our political autobiographies involved a strong memory of 'knowing' race and racism at a very young age, despite growing up at different times and in different regions of the world.

just world. I have already accepted the emotional nature of this work in making sense of my own story, but now I would like to think about what it means to fully embrace the human connections in making sense of other people's stories. Researchers are not saviors, but we still have opportunities to develop relationships with people. Through those relationships are opportunities to engage in praxis that embodies love, dignity, and humanity. Although that might not fully alleviate the pain of oppression and injustice, it still is worthwhile.

This Dissertation Study

This study was a multidimensional research site wherein data were generated both in monthly meetings and across site visits of a working group of five prospective K-8 teachers over a seven-month period. I organized this voluntary group, and our activities were not associated with required coursework in their teacher preparation program. We focused on developing our mathematics teacher noticing across multiple contexts, including video and in-person analysis of children, with the following goals:

- Expand the way we notice mathematics and mathematical practices in children's lives
- Appreciate children as mathematical beings who engage with mathematical ideas outside of mathematics classroom spaces
- Reflect on narratives about mathematics in connection to identity, teaching, and learning

Prospective Teacher Participants

Eleven prospective teachers responded to my email solicitation inviting elementary education students to participate in a research study and a working group focused on learning to notice children's mathematical practices (Appendix A). I sent this email to all students enrolled in an elementary mathematics content course on number and operations at the university within the past two years (Fall 2013, Spring 2014, Fall 2014, and Spring 2015 semesters; 612 total

students) using a bulk email server. I arranged an informational session over dinner to explain the project in person and get to know each prospective teacher. Five prospective teachers ultimately chose to participate in this study: Ann, Beth, Elise, Kate, and Liv. All names are pseudonyms chosen by each prospective teacher.

Across the working group members, there were a range of interest in grade bands (lower elementary, upper elementary, and middle grades). All prospective teachers expressed interest and enthusiasm about a broader view of mathematics in education. Three prospective teachers had concentrations on mathematics in their elementary education major and one prospective teacher was pursuing a mathematics minor in her degree program. While these prospective teachers are not yet admitted to the College of Education, I wanted to note that this proportion of elementary education majors with a concentration on mathematics is not representative of the teacher preparation program enrollment. In fact, admission is limited; mathematics is the only subject area concentration that requires a supplemental application. Four of the five prospective teachers had a minor in Teaching English to Speakers of Other Languages (TESOL). Although this proportion is not representative of the teacher preparation program enrollment of TESOL minors, I suspected this overrepresentation might be because these prospective teachers who volunteered have interests in equity efforts for underserved groups in schools.

I introduce the prospective teachers in this study with information about their school mathematics experiences as a window into their stories. I drew on excerpts from our first writing activity, a mathematics autobiography (Aguirre et al., 2013), where each prospective teacher described previous experiences with mathematics in school and how these experiences shaped who they wanted to be as a teacher.

Ann. Ann was a White female student pursuing an Elementary Education degree with a focus on mathematics and a teaching minor in Teaching English to Speakers of Other Languages (TESOL). She was in her second year at the university and entered our working group at age 19. Ann described the K-5 school she attended as "very diverse" and known for its English language learning program. For grades 6-12, she moved to a suburban city near Detroit, Michigan, which she identified as her hometown, and described those schools as "not very diverse". All schools in her K-12 experiences were large and well resourced.

Although Ann did not have a school placement at the time of this study, she did have previous experiences with children through babysitting, working at a children's summer camp, and tutoring in elementary schools. I was not surprised that Ann was focusing on elementary mathematics in her degree program because she described her experiences with school mathematics as "easy, organized, fun, [and] clear". In joining the group, Ann initially noted that the most important issue for mathematics education is "making sure all students understand the material well and can connect it to other topics in math and have a solid math foundation." She alluded that this issue is relevant to her future teaching practices being "clear and organized".

Ann described her experiences with school mathematics as "something that came very naturally to [her]," with mathematics being her best subject throughout middle school and high school. She appreciated her mathematics teachers who supported her learning by explaining concepts in multiple ways. Ann's great experiences with her mathematics teachers were "a big part of the reason why [she wanted] to teach math," and she chose mathematics as her subject area focus in elementary education (K-8) at the university. She briefly doubted this decision, though, while taking calculus as part of her required college coursework, stating, "I felt lost and helpless, and nothing that I did to prepare for the class was being reflected in my grades."

Beth. Beth was a White female student pursuing an Elementary Education degree with a focus on mathematics. She was in her second year at the university and entered our working group at age 19. Beth attended small elementary and middle schools, graduating with 60 classmates. She then attended a large high school that she described as "a very well respected school that held high standards". Her graduating high school class had 700 students. All schools in her K-12 experiences were public schools in suburban areas near Chicago, Illinois.

Although Beth did not have a school placement at the time of this study, she did have previous experiences with children through service learning in a first-grade classroom, coaching a swim/diving team, and observing and teaching in a fourth-grade classroom during her senior year of high school for a class project. Beth described her experiences with school mathematics as "highs and lows, mostly highs". In joining the group, Beth initially noted that the most important issue for mathematics education is "making sure students don't fall behind and…the material is known, not just memorized for an exam". Beth was one of my former students in an elementary mathematics content course focused on number and operations (Fall 2014).

Beth described experiences with tracking in elementary school where students were placed across three levels; she remembered "always being in the average, middle group, with an occasional change up or down." While she disliked the frequent timed tests in elementary school mathematics, "hard work and good grades fueled [her] into liking math" in middle school. In high school, Beth was placed on an advanced track in mathematics and encountered challenges with calculus—in part because the subject seemed more abstract than other mathematics and in part because she had four different teachers come and go throughout the year. She noted her love for mathematics as the reason she chose it as her subject area focus in elementary education.

Elise. Elise was a White female student pursuing an Elementary Education degree with a focus on mathematics and a teaching minor in TESOL. She was in her third year at the university and entered our working group at age 20. Elise attended schools "in a predominantly White, middle class suburban community" near Detroit that were known for "being good at football". She also described her schools as being very well resources with many facilities.

Although Elise did not have a school placement at the time of this study, she was a reading tutor through a university-organized program. She also had previous experiences with children through nannying, helping teachers in high school classrooms, tutoring in an afterschool program during her first year placement, tutoring in a middle school during her previous year's placement, and Elise described her experiences with school mathematics as "male-dominated, fast-paced, [and] similar". In joining the group, Elise initially noted that the most important issue for mathematics education is "making curriculum applicable to students', especially females', lives" and stated that this issue is important to her as a teacher because she wants "to teach math… and be a model of a female teacher".

Elise described her experiences with school mathematics as invariably routine: each day reviewing the previous homework, a lesson on new material, and a new homework assignment consisting of questions from the textbook. In middle school, Elise was placed on an advanced mathematics track. She lost a bit of confidence with her mathematics work "because even though [she] could do advanced math, [she] still struggled and it was not easy." Overall, Elise described herself as "never over the top excited for math," but she did enjoy the subject. She also attributed much of her success to her female mathematics teachers who "showed [her] that math wasn't just for boys/men and that it was totally fine for girls to enjoy it or like the subject."

Kate. Kate was a White female student pursuing an Elementary Education degree with a focus on language arts and teaching minors in mathematics and TESOL. She was in her third year at the university and entered our working group at age 20. Kate described her K-12 school district in a suburban area near Chicago as having a large population with a majority of White students. Her high school had approximately 4000 students, was well resourced with "smartboards, computers, and iPads in many of the rooms", and was known for their "music program, sport teams, and competitive atmosphere".

At the time of this study, Kate tutored a 5th grade student every week as part of her required coursework in the elementary teacher certification program. Additionally, she had previous experiences with children through her work at a childcare center, afterschool English Language Learner support at an elementary school, and as a clarinet tutor for high school. Kate described her experiences with school mathematics as "challenging, supportive, struggle, confused, [and] engaging". In joining the group, Kate initially noted that the most important issue for mathematics education is "making sure to present material in various ways so that students truly grasp the math topics and concepts" and pointed to how she identifies as a visual learner who struggled with mathematics at times, and thus, wants to "make math accessible for every type of student". Kate was one of my former students in an elementary mathematics content course focused on number and operations (Fall 2013).

Kate enjoyed elementary mathematics in school and was placed on an advanced track in middle school. Over her high school years, she gradually lost interest in mathematics as it "became more tedious and challenging." Kate reflected on "how different math courses require more speed, but also patience to overcome challenges," stating, "early mathematics for young children can be as challenging as high school calculus for older students." She hoped to

emphasize to her future students the importance of discovery and connections across mathematical ideas, even though there are many rules in mathematics.

Liv. Liv was an Asian female student pursuing an Elementary Education degree with a focus on language arts and a teaching minor in TESOL. She was in her second year at the university as an international student from Indonesia and entered our working group at age 19. Liv described her K-12 school as a private Catholic school with approximately 1000 students that was ranked within the top 10 schools in Indonesia and known for its science and mathematics programs.

Although Liv did not have a school placement at the time of this study, she did have previous experiences with children through working at a children's computer course owned by her aunt, completing her service learning at an elementary school last fall, and spending the past summer studying abroad with school visits in Japan. Liv described her experiences with school mathematics as "hit-and-miss with success". In joining the group, Liv initially noted that the most important issue for mathematics education is "showing how [math is] not difficult or scary" and explained that this issue is relevant to her as a teacher because she did not see herself as successful with mathematics until interactions with her high school teachers.

Liv described her experiences with school mathematics as "nothing but frustration and aversion," filled with failing grades and extra help from her teachers, family members, and tutors. Although Liv understood mathematics in class, she received low scores on exams often for errors in calculations. She prepared for a mathematics national exam in sixth grade and earned a score of 76%, which shifted her view of mathematics as a subject that she could do well with some work. In middle school, Liv still did not see mathematics as an easy subject but "if [she] dedicated time and effort, [she] could succeed." As a future teacher, Liv seeks "to break

down all the typical stereotypes about mathematics for [her] students," emphasizing that mathematical skills are not inherent.

Data Generation

I chose to pursue ethnographic traditions in this work because my active participation in the working group allowed me to develop relationships with the prospective teachers across the multiple contexts we navigated. In this framing, I drew on ethnographic participation that allowed "access to the fluidity of others' lives and enhances sensitivity to interaction and process" (Emerson, Fretz, & Shaw, 2011, p. 3) during my engagement with the prospective teachers. Although my study is not an ethnography in the classic sense, the methodological tools of ethnography, such as participant observation and field notes, allowed me to capture the social complexity of our working group conversations. Data were generated through site visit activities, written and verbal reflections during our working group meetings, and individual interviews. Appendix C provides an outline and overview of our working group activities.

Site Visits. One purpose of the site visits in our working group was to explore and be immersed in multiple contexts for learning to notice children's mathematical practices. These site visits served as experiences we drew upon during our working group meeting activities and discussions as we debriefed what we learned from our visits. Our first site visits were mathematics nature walks at locations near the university chosen by the prospective teachers: a children's garden and a river trail. I chose a local science museum for our second site visit as a group. The last visit was a "your choice" site where each prospective teacher selected a location to individually engage in noticing activities.

Working Group Meetings. During our seven working group meetings, we discussed research-based mathematics education readings, participated in activities related to our noticing

work, and engaged in reflections on our own learning. For example, one of the first writing activities was to write a mathematics autobiography (Aguirre et al., 2013) about previous experiences with mathematics in school and how these experiences shaped who we wanted to be as teachers. These autobiographies were kept by each prospective teacher in her own teacher noticing journal, which served as a space to document reflections, record observation notes from site visits, and organize the resources we produced in the group. I made photocopies of journal pages after our final group meeting and returned these journals to each prospective teacher at her final interview.

An example of a teacher noticing journal entry from Meeting 1 was a 'free write' reflection to the following prompt:

> Choose one of the narratives [from our initial brainstorming, see Figure 1 for example] as a topic. (You may also draw on a new narrative about identity and mathematics). Respond to this topic:
>
> - How do you feel about the narrative?
> - How do your experiences (especially those you wrote about in your mathematics autobiography) relate to the narrative?

I frequently revisited our conversations about narratives about people and mathematics as a primary thread in our working group goals.

Another example of working group activities involved a video-based noticing task: a YouTube clip of preschoolers at a sensory table (https://youtu.be/fdZJiWnxhg0). I initially shared this link in my email to solicit participants for this study, and multiple of the prospective teachers mentioned to me during the informational meeting that they were interested in how we could connect mathematics to what the preschoolers were doing at the table. We watched the video clip together during our first working group meeting and had a discussion around the

following two framing questions: (1) What is mathematical about what the children do at the sensory table? and (2) How are the children using mathematics and mathematical practices? This task was not disconnected from other activities in the working group meeting. We also read and discussed a chapter by Parks (2015) to think about exploring mathematics on the playground. I revisited this video clip activity with each prospective teacher during the final interview.

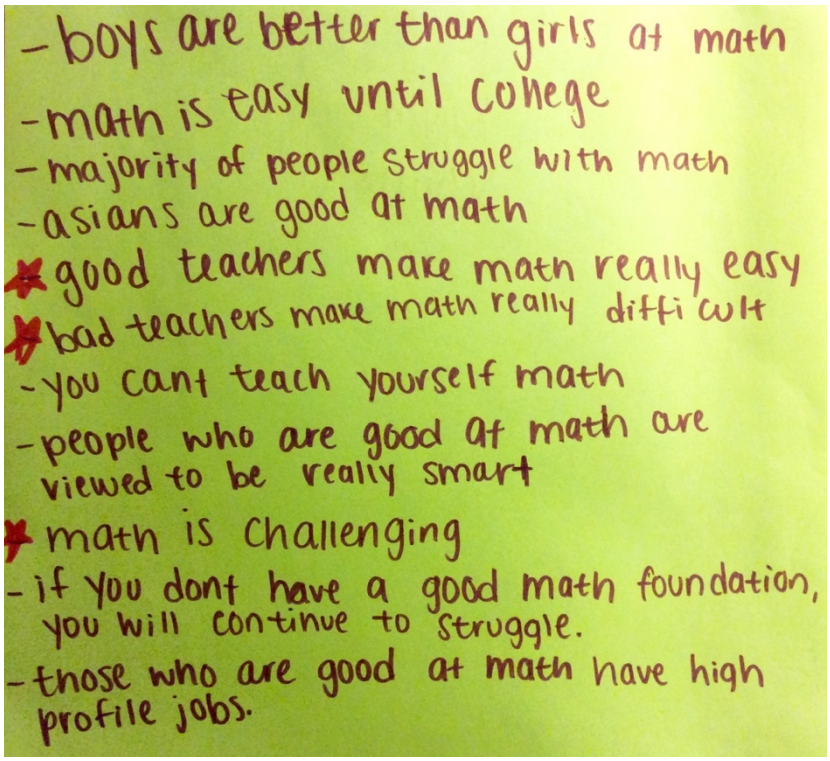

Figure 1. Ann's identified narratives about mathematics and identity from initial meeting.

Interviews. I conducted two individual interviews with each prospective teacher, one at the end of fall semester activities and one at the end of our timeline in the working group. I purposefully chose not to conduct individual interviews at the beginning of fall semester because I did not want my first interaction with each prospective teacher to be in a research interview setting. Instead, I wanted to emphasize engaging with and reflecting on mathematics teacher noticing in multiple sites as the primary function of the group and my dissertation work as secondary. All interviews included questions that focused on mathematical identity narratives

across different contexts, such as contexts within schools and contexts outside schools (see Appendices D & E for interview guides). One feature of this research was that part of our activities involved revisiting and analyzing our own words (drawing on Marx, 2006) to tease out nuances in our discourse. During interviews and selected group meetings, I shared sections of raw transcripts and my analyses with the prospective teachers as "member checks" (Lincoln & Guba, 1985) for feedback on my interpretations and representations of their meaning making.

Data Analysis

My data analysis methods drew on case study research (Stake, 2005; Dyson & Genishi, 2005). I engaged ongoing analysis during data generation using researcher reflections as a starting point for identifying and focusing on interactions from our working group meetings. Primary themes of interest include mentions of mathematics identities through recognizable storylines about mathematics and mathematics education (e.g., "math is often viewed as a man's subject or profession" [Elise, Written Reflection, 10/19/2015]). After the conclusion of our working group, I conducted open coding of a selected subset of transcribed data with a general focus on my research question (stories about mathematics, children, and mathematics education). Then, in subsequent iterations, I used memoing and axial coding to refine and consolidate codes to generate themes (Creswell, 2013).

During this recurrent and messy process, I drew on Tracy's (2013) perspective on analysis as "playing, thinking, returning, and cycling through the maze enough times, and with enough creative attention, to be able to recognize a significant and interesting path along the way" (p. 224). My sensemaking and argument building involved exemplars and vignettes. I selected exemplars as "significant and multifaceted examples" (Tracy, 2013, p. 207) that I identified through coding, which summarized what I saw going on in the data. I also used

vignette as "a focused description of a series of events taken to be representative, typical, or emblematic" (Miles, Huberman, & Saldaña, 2014, p. 182). For example, I engaged stories with prospective teachers about gender and mathematics (pp. 83–105) through a constructed vignette where we revisited and unpacked a single transcribed conversation.

During our final interviews, I intentionally asked each prospective teacher what she wanted teachers, teacher educators, and the public to know about what we might learn from our work together. Their responses guided the framings of the articles in this dissertation. I focused on the prospective teachers' mathematics teacher noticing reflections that extended beyond mathematics content through participation in field experiences across multiple out-of-school sites (Article 1, pp. 51–76). I drew attention to intersecting identities (gender, age, and elementary mathematics) to call for awareness of how interactions might impact young women in mathematics spaces (Article 2, pp. 83–105). I explored the intricacies of connecting mathematics education to identity narratives through an idea mapping activity (Article 3, pp. 110–133).

CHAPTER THREE:

PROSPECTIVE TEACHERS AS PROFESSORS

[ESSAY] When Wisdom of Elders Eclipses Brilliance of Youth ("Don't let them know you are a student")

Given my intersectional identities, sometimes I struggle with being enough. For example, AERA[23] 2014: just a green second year doctoral student. My partner, Jeff, had an accepted presentation. I tagged along to attend the largest educational research conference with him. Two older white-haired people, a White man and White woman, approached us to share our table in between sessions. After a couple minutes sitting, they started talking to us. "So, what do you do?" *Small talk, something I have never fully enjoyed.*

We both gave our rehearsed 'elevator speech,' like the good students we were… Unfortunately, our training did not prepare us for navigating hostile responses. Immediately, the older White man began interrogating our motives to pursue doctorate degrees in education without being public school teachers. The older White woman periodically jumped in, adding to the dismissal. *How could you possibly know anything about education? You have no business being in this field.* All this language, of course, was couched in 'I am trying to understand' rhetoric. But it was abundantly clear that they would not see us as people with experiences or knowledge of value, no matter what I (or Jeff) said.

"I do not pretend to have that experience," I explained. Out of the corner of my eye, I noticed that Jeff stopped speaking and leaned away from the table. He chose to disengage, but I felt obligated to prove to these strangers that Latinx women were competent human beings—a narrative I must constantly attend to and disrupt. I could feel it coming; tears were collecting. Promptly, I also stopped talking so I could attempt to tame my body. *Sometimes quiet is*

[23] American Educational Research Association Conference

violent[24]. Breaking the uncomfortable silence, the older White woman asked, "Oh, so you teach *math* to teachers?"

"Yes," I shortly replied. I wished to leave this space, but I am also stubborn. After all, we were sitting here first before this verbal attack.

"Well, that's good. We really need people to teach math to teachers."

Wait a second. Up until now, I had no worth. I say I teach *mathematics* to teachers, and then I am permitted to exist? My redeeming value to them was that I could 'do' math. (But I could not possibly learn anything about education.) This conversation was not the first time I had been judged as incompetent (by people who literally knew nothing about me), and it certainly will not be the last.

The first person I told about my experience was another graduate student in my cohort. He also presented at AERA that year, and we met up with him for dinner that night. Looking back, it was one of those moments where the words just wanted to come out of my mouth, even though I was slightly unsure of how he would respond as a former public school teacher for over ten years. After I finished my story, he simply replied, "People are jerks." It was exactly what I needed to hear to momentarily let go of my anxiety. I did not share this story with my advisor until a year and a half later; I knew if I did I would just start sobbing. And I had been doing a lot of that during the middle years of this PhD program.

Managing My Intersecting Identities and Insecurities

Gender and age are strongly linked in my experiences as a (still) young woman. When I was a young girl, I wanted to be older. I remember how awkward it was, though, to refer to myself as a 'woman' for the first time. *I felt like an imposter.* I tried to forget the countless times

[24] Lyrics from Twenty One Pilots, "Car Radio" (Joseph, 2011)

people gave me (supposedly) helpful advice to dress older or speak older to be taken seriously by my students. “Don’t say ‘like’ so much.” “Wear more formal attire.” “Don’t seem like a student. They’ll never see you as an authority.” I absolutely despised the clothes my mother would buy for me—pantsuits and blazers that did not match my body. I felt like an infant who was dressed up for a photoshoot: adorable, but you know it is a temporary costume. Now, women’s clothing fits me, but comments about my age have not stopped. The world is funny sometimes.

I gauge my visible appearance based on unsolicited comments from strangers. One time, the gate agent at the airport asked me if I was flying alone. I later realized he thought I was an unaccompanied minor. For a while, I looked sixteen and not old enough to be buying alcohol. I ‘grew’ to look eighteen, still too young to be at a bar. Many shocked reactions to seeing ‘1989[25]’ on my license. And now I am in an ambiguous stage where I “look eighteen” to some people and a “ma’am” to other people.

I no longer desire to be older; I just want people to stop pointing out my age to redirect, dismiss, or ignore me. What I have come to realize, though, is that age is an important part of our intersectional identities and discourses. The problem was not that I needed to ‘act older’ (whatever that means); it’s that we are not valuing young people for who they already are and how they engage in the world. I am drawn to humanizing research and culturally sustaining pedagogies because loving relationships are central to the work. I wonder what mathematics education would look like with a normalized emphasis on love and healing?

Some of my most disheartening experiences within mathematics education communities have been associated with feelings of not being wanted, especially during times when I am

[25] I used to avoid identifying my birth year because I disliked the ways people seemed to treat me differently afterwards. Now, I do not care as much, partly because I have embraced age (and generation) as an important piece of my identity.

seeking love. At a professional conference talking to a scholar I admire and having them[26] pick on my language, making me feel unworthy for saying the 'wrong' words. In a professor's office, unable to control my crying rage because I felt like they were too busy to give me the time of day (even though I approached them to share, in confidence, that I was dismayed by marginalizing interactions with a fellow colleague). I was embarrassed to cry, and frustratingly enough, it was a rare moment where I felt seen. At another conference where I confided to a professor that I desired community, as a graduate student of color, with other scholars (faculty) of color—to which they suggested to me that faculty and students should have different spaces.

I share these experiences, not with a malicious intent nor to freeze people in time, but rather to honor the impact that these interactions had on me. *Time and time again, I am alone.* I currently make sense of these vulnerable moments as connected; specifically, mathematics education is unable to provide a consistently sustaining, loving space that I so desperately yearn for. I mostly find this love and life from communities outside of mathematics education, such as groups who engage critical race studies in education. No space is perfect, but I do feel a more loving openness that 'fits' with my so-called 'touchy-feely' heart. *I was never meant to survive in academia.*

The few spaces within mathematics education that I feel most loved are with people close to my age. I currently make sense of this difference as relational: I am not necessarily trying to gain approval from a constructed hierarchy of professor/student. That is not to say that hierarchical positionings are never offered through our conversations. Rather, I am much more comfortable rejecting any suggested hierarchies of authority by joking about our shared

[26] I use the singular pronoun 'they/them' because these experiences, while very personal and painful, are interactions with people who I still maintain contact and for whom I respectfully admire. In masking these gendered identifiers, I seek to decenter individual people and focus on a culture and pattern of interactions within academia.

'generational' experiences that existed before our 'academic' lives (e.g., as an angsty teenager writing AIM[27] away messages where I would write song lyrics to express the 'story of my life' with dramatic flair). I have accepted that I may not share some of these experiences with other professors or my older colleagues who did not grow up with the internet surge. However, I do wonder how my experiences feeling unwanted and unloved might be connected to all-encompassing, hierarchical positionings of expert-/novice-ness.

Expert/Novice: To Be a Professor…

I view age as connected to expert/novice borders because of its embeddedness across our discourses and institutions. Schools primarily group children by age, creating grade levels. Youth who engage political commentary on social media often receive critique suggesting that their thoughts do not matter because of their age (and assumed lack of knowledge). President Donald Trump often is called a '5-year-old' because being childish is viewed an insult (e.g., '*just grow up*'). Accolade lists for "30 under 30" that recognize exceptional work by young people. Many times during graduate school people have praised me for being 'so articulate.' I used to think that comment was racialized (I am so articulate… for a brown person), but now I have started to see that comment as also aged. I am so articulate—or mature, knowledgeable, successful—for being *so young*.

I have spent nine consecutive years navigating higher education institutions with a 'student' status. Through these experiences, I wonder why faculty are not constructed as students (besides 'lifelong learner' rhetoric that still maintains their expert status) and students are not constructed as experts. A student subject position, often intersected with age, is constructed within this hierarchy as inferior with assumed deficiencies from a lack of knowledge and 'life'

[27] AOL Instant Messenger

experience. One way I have tried to manage this position is to attempt to 'catch up' on experiences—a compulsive need to do as many things as possible. This desire might be partly connected to how middle-class[28] millennial generation children were parented, which fused a convergence between an obsession with metrics from audit culture and empty promises from a myth of meritocracy. I, and many other millennials, were left unsatisfied, unimpressed, and a bit burnt out.

I have been described as rebellious on many occasions with an undertone of concern that I am disrespecting my elders (like young people, especially those millennials, do). What I find funny is that I was raised to follow hierarchies of seniority: under Catholicism, in the household of a Marine, on a competitive dance team that privileged seniority rank to line up at the water fountain, and in countless micro-interactions living in a culture deep in the heart of Texas. So, I do not see my engagement as rebellious; I see it as living as a full human being. After all, we are all just wandering around the world over time and space.

I am not saying that we should never appreciate 'expertise.' Rather, I question whether our constructions of expert/novice are also embedded with age hierarchies, and if so, could those hierarchies be dismantled? What might be possible for mathematics education if we acknowledged that each person embodies a plurality of expertness and noviceness at the same time? What if we embraced an alternative perspective on expertise that made it difficult to construct hierarchies because we could relate "across our human differences as equals" (Lorde, 1984, p. 115)?

[28] In reflection, I am not sure that I can speak to the nuances of the ways class might intersect with how millennial children were parented. Although I make an essentializing reference to 'middle class' in this sentence, I am primarily speaking to my personal experiences growing up in a middle-class family with disposable income to "do as many things as possible," such as summer camps, violin lessons, and dance team.

At the 9th meeting of Mathematics Education and Society, I learned about *mujaawarah*, which is a gathering of people who seek to learn, understand, and act (Fasheh, Abtahi, & Chronaki, 2017). A harmony of wisdom and wellbeing is embodied as each person who joins the *mujaawarah* acts as a professor—someone who professes through what they know, given their body, experiences, and gifts. An emphasis is placed on "what s/he does well, useful, beautiful, giving, and respectful as one's own worth rather than being part of a hierarchical or normative evaluation of worth" (Fasheh et al., 2017, p. 196). As an alternative to controlling institutions, "each *mujaawarah* grows in accordance with its inner dynamics, and interaction with its surroundings" (Fasheh, 2015, p. 48).

What I love about *mujaawarah* is that to be a professor is to be in community and to share offerings through a collective. Expert/novice, then, is exposed as a false dichotomy grounded in hierarchies of dominance. Instead, this duality is dissolved in favor of recognizing value of each human being, not to be comparatively better than others but to support collective efforts and to recognize that we are all shaped by each other. What might mathematics education (or doctoral education) look like if it embraced a spirit of *mujaawarah*? Is *mujaawarah* incompatible with formalized education structures? What might be gained from crossing or living within expert/novice borderlands in these spaces?

"Math doesn't always have to be solving equations": Blurring Boundaries through Early Field Experiences in Out-of-School Contexts

Mathematics teacher noticing as a pedagogical practice—attending to, interpreting, and responding to children's mathematical thinking—is growing within mathematics education communities. Much of the research literature primarily focuses on supporting teacher noticing of children's mathematical thinking within classroom contexts (Jacobs, Lamb, & Philipp, 2010), such as analyzing classroom artifacts (e.g., Goldsmith & Seago, 2011) and video recordings (e.g., Star & Strickland, 2008).

Recent efforts to support teachers make connections between mathematics and children's funds of knowledge, however, often involve professional work outside of classrooms where teachers learn about children's lived experiences and communities (Aguirre, et al., 2012; Aguirre, Mayfield-Ingram, & Martin, 2013). For example, Civil (2007) highlighted an elementary classroom garden project with children's mathematics of exploring area, perimeter and scale. In designing this project, the teacher drew on lived experiences by mathematizing gardening practices of her students and their families. Small groups of students in the classroom cared for a real garden area enclosed with chicken wire. In the garden project, students were tasked with figuring out how to make the garden bigger without adding more chicken wire to expand the area. Students focused on maximizing the area of their garden, given the same perimeter. While there is a growing expectation that teachers draw on children's funds of knowledge to support mathematics learning, this kind of professional work requires an ability to notice mathematics in out-of-school contexts.

Prioritizing mathematics teacher noticing with a focus on out-of-school contexts can help to transform mathematics classrooms into spaces where historically marginalized groups of students (e.g., by race, gender, class, language) may thrive because teachers can build on

connections between children and mathematics that extends traditional curriculum. McDonald, Bowman & Brayko (2013) noted that there is little research on how teachers learn to develop relational practices of teaching—practices that center relationship building to learn about and engage with children, families, and communities—to better connect with their students. They examined opportunities for prospective teachers to develop relational teaching practices in teacher preparation through community-based organization contexts, particularly with commitments to social justice. The authors argued that community-based organization placements are rich contexts in which teacher candidates learn how to "see students," which is important for learning how to build relationships with students and their families in sustaining ways to support learning. In addition to community-based placements, other typical examples of prospective teacher education activities in out-of-school contexts include service learning experiences (e.g., Borgerding & Caniglia, 2017) and afterschool outreach program engagement (e.g., Cartwright, 2012).

In this paper, I argue that early field experiences in out-of-school contexts provide prospective elementary teachers opportunities to open up mathematics and mathematics education through blurring limiting boundaries constructed around mathematics. I highlight a collaboration among five K-8 prospective teachers in a working group that I facilitated focused on learning to notice children's mathematical practices across out-of-school contexts (e.g., children's garden, science museum). This work extends scholarship investigating mathematics teacher noticing by considering the following research question: In what ways do early field experiences in out-of-school contexts support prospective elementary teachers to develop new conceptions of children, mathematics, and mathematics education? In turn, I foreground the

complexities of this practice across contexts to address the needs of our increasingly diverse school populations to combat limiting discourses about children and mathematics.

Relevant Literature

Guided by scholarship on learning as participation (Lave & Wenger, 1991), I view *mathematics* in terms of participation in the practices and discourses involved in *mathematical experiences*, which must include aspects of mathematics and mathematical practices, such as people engaging with quantities, patterns, and spatial reasoning. Mathematics, in this view, validates multiple ways of meaning making and practices involving these mathematical ideas. Mathematical experiences include the intersections of mathematics and any combination of disciplines and disciplinary ideas. That is, mathematical experiences are not restricted to 'belonging' solely to the discipline of mathematics. By broadening what constitutes mathematical experiences, I directly challenge limiting perspectives about what counts as competencies and engagement with mathematics.

In conceptualizing ways of knowing mathematics, Nasir, Hand and Taylor (2008) argued that mathematics knowledge is fundamentally linked to cultural practices. Many scholars have also highlighted this argument through their studies of out-of-school mathematics practices (Carraher, Carraher, & Schliemann, 1985; Nasir, 2002; Saxe, 1988; Taylor, 2009). I align with these scholars because their work to broaden and legitimize multiple knowledges and practices centers on addressing inequities in mathematics education that disproportionately marginalize students of color in classrooms.

Furthermore, I draw on Gutiérrez (2012) to conceptualize dimensions of equity in mathematics education: *access*, *achievement*, *identity*, and *power*. An access dimension of equity refers to an equal distribution of resources for students, such as quality curriculum, technologies,

and opportunities to learn rich mathematics. Achievement involves student outcomes, which are typically measured by standardized test scores and representation metrics of groups of students in higher mathematics courses and mathematics-based careers. A dimension of identity emphasizes how students engage meaningful mathematics by drawing on their knowledges and resources while connecting to a broader world. A power dimension centers social transformation that seeks to reimagine and create a more humane and just mathematics education. My efforts to blur boundaries to extend possibilities for what count as mathematical and who can do mathematics fit within Gutiérrez's critical axis, foregrounding equity dimensions of identity and power in elementary mathematics teacher education. I bring together three areas of mathematics education scholarship in this work: mathematics teacher noticing, mathematizing, and mathematical identity narratives.

Mathematics Teacher Noticing

Mathematics education researchers have emphasized the role of students' mathematical thinking in teaching and learning mathematics and argued for developing prospective teachers' capacity to notice students' mathematical thinking to support and sustain their continued learning to teach mathematics beyond teacher preparation (van Es & Sherin, 2002; Sherin, Jacobs & Philipp, 2010). Teacher noticing, as a professional practice, involves more than just the act of observing behavior; it requires specialized knowledge and intentional decision-making that is specific to teaching.

Within mathematics education, Jacobs and colleagues (2010) define this construct as *professional noticing of children's mathematical thinking,* which involves three interrelated skills: attending to, interpreting, and deciding how to respond to children's mathematical thinking. Attending to children's mathematical thinking involves attention to specific aspects of

mathematical approaches and detail in student work. Interpreting children's mathematical thinking involves reasoning and making sense of students' strategies based on evidence of their understandings. Deciding how to respond to children's mathematical thinking involves reasoning from attending and interpreting students' strategies to make an informed decision to respond to students.

Mathematizing

I broaden mathematics teacher noticing by connecting to literature on mathematizing, and particularly, looking at children outside of classrooms, not just inside of classrooms. In framing the mathematizing literature, I consider mathematizing children's lived experiences as particularly relevant for my focus across multiple contexts. I conceptualize mathematizing broadly as reading and writing the world with mathematics (Gutstein, 2006). Mathematizing, as a mathematical practice, involves using mathematical ideas to represent quantities and relationships in situations (Lo Cicero, Fuson, & Allexsaht-Snider, 1999; Rasmussen, Zandieh, King, & Teppo, 2005; Treffers, 1993). Through mathematizing the world, people might take a mathematical lens to address global issues (Gutstein, 2006) and to investigate inequities within their local contexts (Aguirre et al., 2013).

Noticing and mathematizing are two conceptualized practices that mathematics education researchers highlight as valuable for teaching and learning mathematics. I am bringing these two practices together in my view of broadening teacher noticing to include a more holistic perspective of children's mathematics and mathematical practices both inside (where we typically focus on noticing our children's mathematical thinking) and outside classroom spaces. I connect this work to mathematical identity narratives, which are entangled in our interactions and practices teachers might enact in classrooms.

Mathematical Identity Narratives

My explicit attention to mathematical identity narratives stems from how human beings make meaning of their world, which is shaped by experiences, values, and emotions. This perspective drives how I think about mathematics teacher learning. Goldsmith and Seago (2011) eloquently stated:

> Teachers' interpretations of classroom artifacts are influenced by the very ways they think about mathematics and mathematics teaching and learning. Teachers view video or read a student's worksheet through the lens of their own knowledge, beliefs, and experiences; this lens shapes their very perception of the artifacts themselves (p. 170).

I consider narratives important in mathematics teacher learning because these narratives contribute to shaping the lens through which we see the world. Drawing on Nasir and Shah (2011), I view narratives as dynamic shared storylines of circulated discourses, which are "continually taken up, reproduced, and resisted in multiple ways in daily life" (p. 26). Specifically for mathematics education, these narratives are stories that teachers tell about children, about themselves, and about mathematics. This includes (but is not limited to) racialized narratives (Larnell, 2016; Martin, 2006; McGee, 2013; Nasir & Shah, 2011), gendered narratives (Hottinger, 2016; Walkerdine, 1998), and disciplinary narratives (e.g., mathematics is fixed and ability is inherent).

Common recirculated discourses within mathematics education construct dominant narratives about what counts as mathematics and who can do mathematics. For example, stories about mathematics often emphasize that it is about solving equations, either right or wrong, and not relevant to people. Additional common stories include notions of being a 'math person' (or not), which suggests that mathematics belongs to certain people. That is, mathematics might be viewed as a (White) man's subject or profession, or racial stereotypes such as 'Asians are good

at mathematics.' These examples are recognizable narratives that are well entrenched in schools (and, of course, our broader society) that constrain what is possible for mathematics education.

Recirculation of these tropes construct a boundary between mathematics and disciplines (what counts as mathematical) and mathematics and people (who can do mathematics). Consequently, some students are marginalized by traditional practices in mathematics classrooms. While building on students' funds of knowledge might be one way to mitigate these issues, I argue that supporting teachers to see children's mathematical strengths in out-of-school spaces is important for disrupting constraining boundaries around mathematics. I draw on mathematics teacher noticing, broadly conceptualized with mathematizing and mathematical identity narratives, as a tool to engage this work.

Method

This study was a multidimensional research site wherein data were generated both in monthly meetings and across site visits of a voluntary working group of five prospective K-8 teachers over a seven-month period. I organized this voluntary group, and our activities were not associated with required coursework in their predominantly white teacher preparation program at a large public university. We focused on developing our mathematics teacher noticing across multiple contexts, including video and in-person analysis of children, with the following goals:

- Expand the way we notice mathematics and mathematical practices in children's lives
- Appreciate children as mathematical beings who engage with mathematical ideas outside of mathematics classroom spaces
- Reflect on narratives about mathematics in connection to identity, teaching, and learning

Table 1 provides a brief description of our group members based on a self-reported survey answered at our first meeting. I introduce the prospective teachers with information about their

school mathematics experiences as a window into initial ways they described school mathematics and mathematics education coming into this working group. One prospective teacher (Liv) is an Asian woman who is an international student from Indonesia, four prospective teachers (Ann, Beth, Elise, and Kate) are White American women, and I am a Latinx American woman. All names are pseudonyms chosen by each prospective teacher.

Across the working group members, there were a range of interest in grade bands (lower elementary, upper elementary, and middle grades). All prospective teachers expressed interest and enthusiasm about a broader view of mathematics in education. Three prospective teachers had concentrations on mathematics in their elementary education major and one prospective teacher was pursuing a mathematics minor in her degree program. Four of the five prospective teachers had a minor in Teaching English to Speakers of Other Languages (TESOL). Although this proportion is not representative of the teacher preparation program enrollment of TESOL minors, I suspect this overrepresentation might be because these prospective teachers who volunteered have interests in equity efforts for underserved groups in schools.

Table 1. Mathematics Teacher Noticing Working Group Members[29]

Name	Major	Description of School Mathematics Experiences
Ann	Elementary Education (mathematics); TESOL[30] minor	Ann described her experiences with school mathematics as "easy, organized, fun, [and] clear." In joining the group, Ann initially noted that the most important issue for mathematics education was "making sure all students understand the material well and can connect it to other topics in math and have a solid math foundation." This issue connected to Ann's desire for her future teaching practices to be "clear and organized."

[29] Although I am also a member of this working group, I did not include myself in this table because I did not fill out the self-reported survey in my role as facilitator. More details about my experiences with school mathematics are described in the 'Researcher Positionality' section.

[30] Teaching English to Speakers of Other Languages

Table 1 (cont'd)

Beth	Elementary Education (mathematics)	Beth described her experiences with school mathematics as "highs and lows, mostly highs." In joining the group, Beth initially noted that the most important issue for mathematics education was "making sure students don't fall behind and…the material is known, not just memorized for an exam." Beth was one of my former students in an elementary mathematics content course focused on number and operations (Fall 2014).
Elise	Elementary Education (mathematics); TESOL minor	Elise described her experiences with school mathematics as "male-dominated, fast-paced, [and] similar." In joining the group, Elise initially noted that the most important issue for mathematics education was "making curriculum applicable to students', especially females', lives" and stated that this issue was important to her as a teacher because she wants "to teach math… and be a model of a female teacher."
Kate	Elementary Education (language arts); mathematics & TESOL minors	Kate described her experiences with school mathematics as "challenging, supportive, struggle, confused, engaging." Kate initially noted that the most important issue for mathematics education was "making sure to present material in various ways so that students truly grasp the math topics and concepts." Kate was one of my former students in an elementary mathematics content course focused on number and operations (Fall 2013).
Liv	Elementary Education (language arts); TESOL minor	Liv described her experiences with school mathematics as "hit-and-miss with success." In joining the group, Liv initially noted that the most important issue for mathematics education was "showing how [math is] not difficult or scary" and explained that this issue was relevant to her as a future teacher because she previously did not see herself as successful with mathematics until interactions with her high school teachers.

Researcher Positionality

I am fully aware of my role as both a group member facilitating meetings and as a researcher. Both roles are influenced by my positionality as a middle class, Latinx woman who was generally successful in traditional mathematics classroom spaces (i.e., those that privileged abstract and proof-based activities) and as a visibly young mathematics teacher educator and researcher who navigates predominantly white spaces. My commitments toward a more

equitable and just mathematics education is grounded in my experiences with school mathematics as a student and educator.

Upon completing my K-12 education, I believed I was a 'math person' and that math was the only subject area in which I could be successful. I acknowledged stereotypes about girls and people of color and mathematics that were entrenched in schools; however, I wrongly believed that I was somehow different because I could succeed with school and mathematics. These beliefs developed from a toxic system that functions on hierarchies in power relations. I no longer believe in these deficit framings of people, largely influenced by a journey of transformation as I encountered multiple marginalizing gendered and racialized experiences in mathematics spaces. Through my doctoral studies, I made sense of these experiences with feminist and critical race perspectives. I realized that I could not ignore identity narratives as disconnected from mathematics teaching and learning.

My scholarship centers on identity and power as I continue to transform and engage my commitments to equity for a more humanizing and just mathematics education (Aguirre, 2016). I take an interpretive stance in my work that involves continual questioning and deconstructing of dominant narratives about mathematics and identity that may often go unchallenged. For this research, my commitments led me to question how narratives related to mathematical identities potentially shape prospective teachers' noticing of children (and their mathematical practices) in multiple contexts both inside and outside classroom spaces.

Data Generation

I chose to pursue ethnographic traditions in this work because my active participation in the working group allowed me to get close to the prospective teachers across the multiple contexts we navigated. In this framing, I drew on ethnographic participation that allows "access

to the fluidity of others' lives and enhances sensitivity to interaction and process" (Emerson, Fretz, & Shaw, 2011, p. 3) in my exploration with the prospective teachers in this study. Data were generated through two site visit activities (at three locations), written and verbal reflections during three working group meetings, and two individual interviews with each prospective teacher (10 interviews total).

The site visits served as experiences we drew on during our meeting activities and discussions. Our first site visits were mathematics nature walks at locations near the university chosen by the prospective teachers: a children's garden and a river trail. I did not attend these first site visits with the prospective teachers because I wanted to provide space for them to explore without me as a teacher educator leading the group. I did, however, attend and participate along prospective teachers during the following site visit to a local science museum. I chose the science museum as a site because I had previous connections with the location and had visited the space on my own. I focus on these three sites in this paper as out-of-school contexts the prospective teachers visited in small groups.

During our 90-minute working group meetings, we discussed research-based mathematics education readings, participated in activities related to our teacher noticing work, and engaged in reflections on our own learning. For example, one of our working group activities involved a video-based noticing task of watching and discussing a YouTube clip of preschoolers at a sensory table (https://youtu.be/fdZJiWnxhg0). I initially shared this link in my email to solicit participants for this study, and multiple of the prospective teachers mentioned to me during the informational meeting that they were interested in how we could connect mathematics to what the preschoolers were doing at the table. We watched the video clip together during our first working group meeting and had a discussion around the following two

framing questions: (1) What is mathematical about what the children do at the sensory table? and (2) How are the children using mathematics and mathematical practices?

Prospective teachers also participated in writing activities during our working group. For example, the first writing activity was to write a mathematics autobiography (Aguirre et al., 2013) about previous experiences with mathematics in school and how these experiences might have shaped thoughts about being a teacher. These autobiographies were kept by each prospective teacher in her own teacher noticing journal, which served as a space to document reflections, record observation notes from site visits, and organize the resources and artifacts we produced in the group. I made photocopies of journal pages after our final group meeting and returned these journals to each prospective teacher at her final interview.

Due to the voluntary structure of our working group, we did not have a consistent meeting time and location. Consequently, some of our monthly meetings took place at two different times with smaller groups of two or three prospective teachers. All three working group meetings in this paper took place at the university. Figure 2 outlines who attended the site visits and associated group meetings that I describe in this paper. For example, our February meeting occurred during two consecutive weeks: Elise and Liv attended a meeting with me (2/17/2016) and the next week Ann, Beth, and Kate attended a meeting with me (2/24/2016). Both meetings focused on the same activities with recreating a science museum exhibit. Additionally, Figure 2 provides an overview of the examples I highlight in the findings from each site visit context.

I conducted two individual interviews with each prospective teacher, one at the middle and one at the end of our timeline in the working group. I purposefully chose not to conduct individual interviews at the beginning of fall semester because I did not want my first interaction with each prospective teacher to be in a research interview setting. Instead, I wanted to

emphasize engaging with and reflecting on mathematics teacher noticing in multiple sites as the primary function of the group and my research work as secondary. Each interview was videotaped and audiotaped. The first interview lasted approximately 50 minutes and the second interview lasted approximately 90 minutes. All interviews included questions that focused on mathematical identity narratives across different contexts (i.e., within schools and outside schools) and prompts for reflection on their own mathematics teacher noticing. For example, I asked, "Do you consider yourself a 'math person'?" in the final interview to broadly explore that identity narrative and "How has your teacher noticing shaped the way you think about math?" in both interviews to elicit prospective teachers' reflections on their learning.

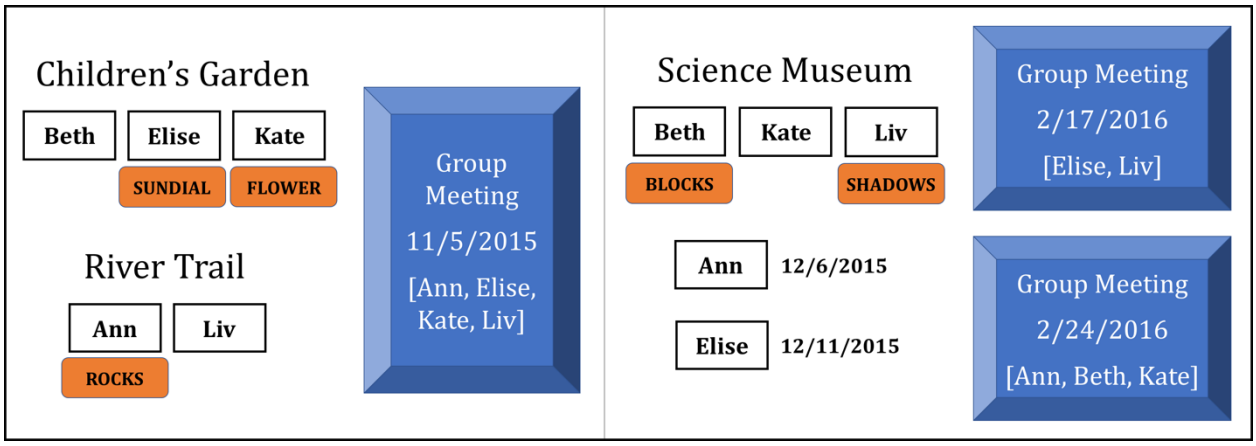

Figure 2. Participants attending site visits and group meetings.

One feature of this research was that part of our activities involved revisiting and analyzing our own words (drawing on Marx, 2006) to tease out nuances in our discourse. During interviews and selected group meetings, I shared sections of raw transcripts and my analyses with the prospective teachers as "member checks" (Lincoln & Guba, 1985) for feedback on my interpretations and representations of their meaning making. During our final interviews, I intentionally asked each prospective teacher what she wanted teachers, teacher educators, and the public to know about what we might learn from our work together. Their responses guided the

framing of this piece; specifically, I focused on prospective teachers' mathematics teacher noticing reflections that extended beyond mathematics content through participation in field experiences across multiple out-of-school sites.

Data Analysis

My data analysis methods drew on case study research (Stake, 2005; Dyson & Genishi, 2005). I engaged ongoing analysis during data generation using researcher reflections as a starting point for identifying and focusing on interactions from our working group meetings. Primary themes of interest include mentions of mathematics identities through recognizable storylines about mathematics and mathematics education (e.g., "math is often viewed as a man's subject or profession" [Elise, Written Reflection, 10/19/2015]).

After the conclusion of our working group, I conducted open coding of a selected subset of transcribed data with a general focus on my research question (stories about mathematics, children, and mathematics education). In addition to reading and rereading transcribed working group discussions and interviews, I also watched and listened to video and audio from these meetings during the open coding process as a different mode to identify potential codes. Then, in subsequent iterations, I used memoing and axial coding to refine and consolidate codes to generate themes (Creswell, 2013).

Initially, I conducted analysis by physical location. For instance, I coded and identified themes for all data related to the science museum without much attention to data related to the mathematics nature walks. I named two main themes: "Seeing mathematics everywhere" (mathematics nature walk) and "Children's mathematics in 'natural' environments" (science museum). I decided to conduct another iteration of analysis that looked across location contexts because I noticed that the themes overlapped in both the nature walk and the science museum.

After this round of analysis, I regrouped and renamed two themes that appear in this paper: "Mathematics (and more) outside of classroom walls" and "Rewriting stories about people and mathematics."

Through this recurrent and messy process, I drew on Tracy's (2013) perspective on analysis as "playing, thinking, returning, and cycling through the maze enough times, and with enough creative attention, to be able to recognize a significant and interesting path along the way" (p. 224). My sensemaking and argument building involved exemplars and vignettes. I selected exemplars as "significant and multifaceted examples" (Tracy, 2013, p. 207) that I identified through coding, which summarized what I saw going on in the data. I also used vignette as "a focused description of a series of events taken to be representative, typical, or emblematic" (Miles, Huberman, & Saldaña, 2014, p. 182).

Findings

In the sections that follow, I identify two themes from the prospective teachers' noticing work through early field experiences in out-of-school contexts. One theme—mathematics (and more) outside of classroom walls—involves blurring boundaries between mathematics and other disciplines to reframe what counts as mathematical contexts. Another theme—rewriting stories about people and mathematics—involves blurring boundaries between mathematics and people to reframe who engages with mathematics.

Mathematics (and more) Outside of Classroom Walls

Prospective teachers broadened the ways they talked about what counts as mathematics—blurring disciplinary boundaries—during our working group activities. After reading a chapter by Parks (2015) about children's mathematical play, we conducted a mathematics nature walk. Our focus for this visit was to explore what it means to see mathematics in our world by putting

mathematics teacher noticing into practice—taking a mathematics lens to people and contexts outside of classrooms. Beth, Elise, and Kate decided to try out their mathematics teacher noticing at a local children's garden and Ann and Liv decided to visit a river trail. All prospective teachers shared photos from their site visits and discussed reflections on what they learned at our following working group meeting.

Both groups expressed surprise at finding multiple examples of mathematics in their site visits as well as connections between mathematics and other content areas. At the children's garden, there was a sundial section where Beth, Elise, and Kate saw a little boy and his dad playing. At the sundial, you would stand next to the current month marker on the ground and lift your arm to find your arm's shadow at the corresponding time markers on the ground. Figure 3 shows Elise using the sundial at the children's garden to tell the time, 2:30 p.m. Through our debriefing conversation about the sundial, the group made historical connections to telling time. Additionally, we integrated mathematics and science content by connecting geometry (angles and distance) to concepts of shadow, light, and seasons—blurring boundaries between mathematics and physical science.

A common mathematical idea both groups focused on from their site visit observations was seeing shapes in the world. For example, prospective teachers pointed to parallel lines and perpendicular angles in building structures visible along the river trail and within the children's garden, which could also connect to architectural engineering and design concepts. Two photographs we discussed in more detail were of flowers at the children's garden (Figure 4) and rocks along the bank on a river trail (Figure 5).

Figure 3. Elise playing with the sundial to tell time at the children's garden.

Figure 4. Kate's photo of flowers at the children's garden.

Sharing a photo with the group, Kate described how she used her teacher noticing to identify different shapes in the parts of flowers in the children's garden. Later in the debriefing conversation, Liv shared a story about a gardening club at the elementary school in her service learning experience. Students in the club would care for plants in the garden and cook with what they harvested. In sharing this story about gardening with the group, Liv connected back to Kate's flower example,

> **Liv**: …flowers of the same species, they always have a certain number of petals. So if they're always odd then they're this kind of species, if they're always even they're that kind of species. So yeah that's pretty cool. [Group Meeting, 11/5/2015]

Liv's contribution blurs boundaries between mathematics and science disciplines. From a single context of flowers in a garden, we discussed identifying shapes with a mathematics lens. We were also able to consider an integrated mathematics and science lens by counting petals and making sense of patterns across quantities to determine flower species—blurring boundaries between mathematics and botany.

Both groups also pointed to sizes of shapes for comparison purposes. At the river trail, for instance, Ann and Liv made connections to geology with the river currents and flow. Through our discussion, Kate also commented that the smoothness of stones along the river (Figure 5) could connect to erosion.

> **Liv**: If a kid wants to go to the river, they will have to pick the bigger stones to step on.
>
> **Kate**: With the rocks, also, if some of them are more eroded than others, they would be more slippery. [Group Meeting, 11/5/2015]

Again, with a single context of rocks along a river bank, prospective teachers were blurring disciplinary boundaries between mathematics and earth science topics by making integrated connections (size comparison and slipperiness of rocks due to erosion). The prospective teachers

also blurred boundaries between mathematics and nature, challenging dominant perspectives that mathematics is something that is only accessible within classrooms.

Figure 5. Ann's photo of rocks along the bank on a river trail.

Our working group also visited a local science museum after reading a practitioner article by Thomas and colleagues (2015) about professional noticing of children's mathematical thinking and coming up with our own working definition of mathematics teacher noticing. We observed children and families engaged with the bubble exhibit at the museum. One of the sections was a bubble wand area with 3-dimensional shapes (e.g., tetrahedron) that you could dunk into bubble solution and explore ideas of surface tension, surface area, and polygons. For example, Figure 6 shows a cube bubble wand that Elise dunked into the bubble solution.

After debriefing our site visit and planning for future meetings, our group created our own homemade versions of the bubble wand exhibit we saw at the science museum during a meeting. We used pipe cleaners and straw pieces to construct 3-dimensional bubble wands (see Figure 6) to see how well they would work to explore mathematical and science ideas in the classroom. Through creating our bubble wands, we discussed potential connections to

mathematics, such as nets for 3-dimensional shapes, visible polygon shapes as sheets made by the bubble solution, and surface area. We also posed potential questions for students to explore: Why is the shape of a bubble a sphere? Why does dunking the 3-dimensional bubble wand into bubble solution react in the way that it does?

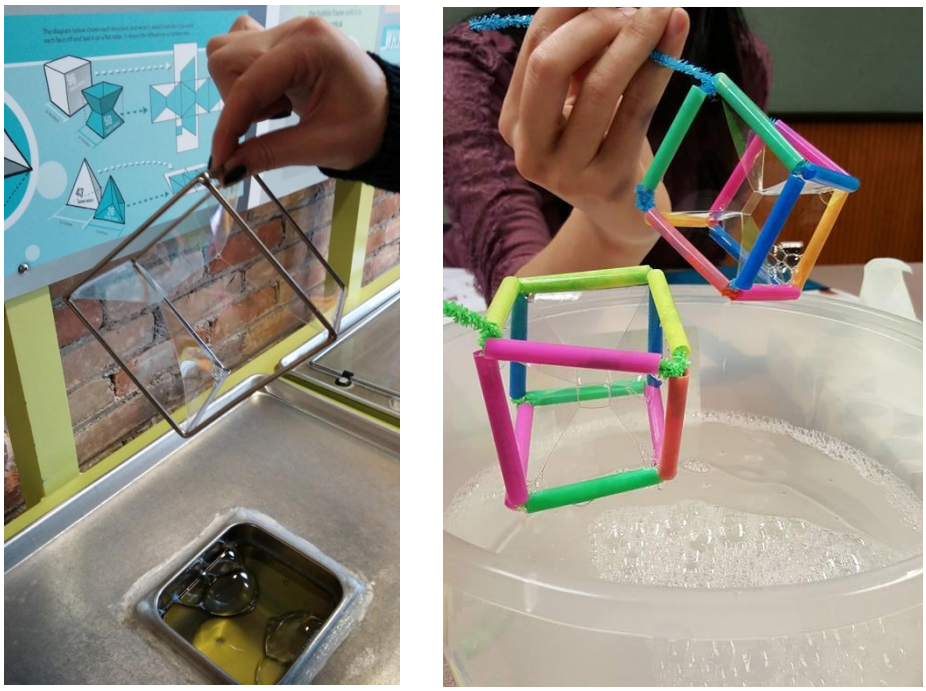

Figure 6. Cube bubble wand at exhibit in a local science museum (left) and recreating our own bubble wands during a working group meeting (right).

To answer these questions, we had to do our own research. Our conversations provided an opportunity to learn about surface tension and surface area with bubble solution. Surface tension, allowing liquid molecules to cohesively stick to each other, makes the bubble solution take up the smallest amount of surface area. A spherical shape is the minimal surface area for a free-floating bubble in the air. For our cube bubble wands, though, the bubble solution attaches to the edges of our structure, creating sheets of bubble solution to minimize surface area.

Our mathematics teacher noticing work in out-of-school contexts opened up mathematics to exist outside of classroom walls, blurring boundaries between mathematics and other 'non-

mathematical' content. Liv highlighted the science museum site visit as important for her mathematics teacher noticing because "every subject – including biology, physics, chemistry, history and math – is practically covered in at least one of their exhibits" [Written Reflection, 11/21/2015]. Like Liv, Beth explored her understanding of mathematics related to other subjects, particularly with how mathematics might be represented in ways other than equations.

> I learned that math doesn't always have to be solving equations. Math is everywhere and always being done. This experience made me think more critically and outside of the box. It forced me to think and learn in ways I normally wouldn't.
>
> [Beth, Written Reflection, 11/1/2015]

Beth's reflection suggests a view of mathematics as a subject that exists outside of classroom walls and connected to other subjects, beyond typical activities in mathematics classrooms such as solving equations. Through developing a new conception of mathematics as not just abstract and procedural, Beth described seeing mathematics as "always being done" by people. While Beth's reframing of "math is everywhere" seems to broaden mathematics as a discipline, I caution a potential danger of how this message might reinforce messages that suggest a supremacy of mathematics in schools and societies. Regardless, this perspective was taken up by the prospective teachers in their reflections about people and mathematics from our site visits. We were not only extending mathematical possibilities to out-of-school contexts, but also rewriting stories about who engages with mathematics.

Rewriting Stories about People and Mathematics

> **Elise**: I think in general, it was just really eye-opening to see there was math in so many different things 'cause I've never thought about this before. I would never consider a kid playing on the playground to be math-related at all. If I went [to the children's garden] just casually I would say, '*Oh, they're just having fun*.' But there's so many different things that are math-related and I feel like that's very useful as a future teacher.

[Group Meeting, 11/5/2015]

Elise's reflection suggests how our site visits in out-of-school contexts supported blurring boundaries between mathematics and people. For example, during our science museum visit, we made connections not only between mathematics and science but also between mathematics and storytelling, imagination, cultures, archaeology, and history—all connected to a variety of ways people engage with mathematics. Many of these connections at the science museum related to children's pretend play with various resources, such as shadow puppets, foam blocks, and climbing structures.

We observed children and their caregivers playing it the block building area (Figure 7). Taking a mathematics teacher noticing lens, the prospective teachers identified mathematical concepts in the children's mathematical play. Beth, for example, noted children stacking blocks and building structures, which she connected to addition, shapes, and balance (Figure 8). Through our discussion, we talked about composing shapes, counting, and pattern building involved in the children's activities.

Figure 7. Block building area in a local science museum.

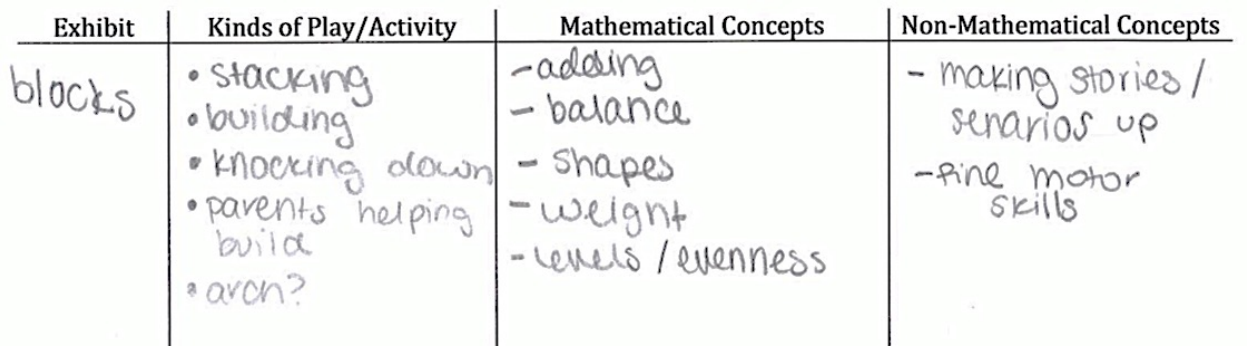

Figure 8. Beth's notes for block exhibit in a local science museum.

Beth also identified non-mathematical concepts in the children's activities, such as making up stories (e.g., playing castle) and how children used fine motor skills to build with the foam blocks. The science museum context provided an experience to see children and caregivers engage with mathematics. In addition to blurring boundaries between mathematics and family activities, prospective teachers continued to blur boundaries between mathematics and play.

Another example we discussed from our science museum site visit was a shadow storytelling exhibit. There was a screen that divided the exhibit area: on one side was a light projector with objects that you could place on a flat table (Figure 9), and on the other side was a space for people to stand and watch.

Like our sundial example from the children's garden, prospective teachers connected mathematics and science concepts related to light, shadow, distance, and size. Liv, however, commented that the exhibit could also have a cultural connection.

> **Liv**: I feel like they should put a little note on that one, though, because there are historic things [children] can learn from that. Like, some cultures actually used shadow puppets to basically entertain themselves before they had TV. [Group Meeting, 11/21/2015]

Liv's contribution not only suggests blurring boundaries between mathematics and disciplines—art and history—but also blurring boundaries between mathematics and cultural activities. For this example, mathematics is connected to people and cultures through shadow play.

Figure 9. Shadow storytelling exhibit in a local science museum.

Across the prospective teachers' reflections on our site visit activities, they discussed seeing mathematics (and mathematics education) in new ways related to children. For instance, Elise stated that she did not previously see mathematics as something that children could be doing almost all day.

> I never really saw math as being something kids are doing almost all day. It makes me want to further analyze and use what the students do mathematically throughout the classroom to help them become more interested. [Elise, Written Reflection, 1/15/2016]

Elise found value in our mathematics teacher noticing activities to support her future students' interest in mathematics. In a later reflection, she commented that mathematics teacher noticing across out-of-school contexts would help her "be able to make math more relatable to students" [Written Reflection, 8/9/2016].

Related, Kate also reframed mathematics as a subject that could be "more approachable to students [to give] math more of a sense" when connected to the outside world [Interview, 1/29/2016]. Kate commented that she "made a conscious effort [after our group meetings] to think about the mathematical concepts being demonstrated while the children played outside and inside" at the daycare where she worked [Kate, Written Reflection, 1/14/2016]. Kate's discussion of mathematics and mathematics education, similarly to Elise, suggests blurring boundaries between mathematics and students. Reframing mathematics as part of what children do across their day and as part of the outside world in which children explore provided them with a new relationship between children and mathematics that they could draw upon as future teachers.

In addition to the organized group visits, each prospective teacher selected a site visit where she could individually engage her mathematics teacher noticing in a location of her choosing. Ann decided to observe the three girls who she babysat. She reflected on how gender narratives connected to her observations of the girls playing with Legos and how this exercise related to her future students as a mathematics teacher.

> [The girls] played games with the Legos such as "house" and "store," as opposed to building spaceships and vehicles. Also, the Lego kits that they used were pink and purple, and were geared more for girls. What this means for me as a mathematics teacher is that I am going to be careful to not enforce these narratives in a way that would make someone feel uncomfortable if they do not fit "their narrative." Being aware of these narratives also helps me to see how a child may feel out of place or like they don't belong if they do not fit the narrative. [Ann, Written Reflection, 5/3/2016]

Ann pointed out seeing societal narratives that uphold gender norms, such as pink and purple colors being associated with toys for girls and pretend play that center domestic commitments. As a future mathematics teacher, she reflected on having an awareness of these gendered

narratives with attention to how students might feel "out of place or like they don't belong" for being different than the recognizable narrative. Ann's reflection suggests blurring boundaries between mathematics and girls by working against stereotypes that wrongly assume girls and women would not do well with mathematical activities.

Discussion

This research highlighted complexities in developing mathematics teacher noticing: prospective teachers might engage in noticing children's mathematical practices both inside *and* outside the classroom. Through early field experiences in out-of-school contexts, prospective teachers engaged opportunities to speak back to deficit discourses that limit who is considered (or assumed to be) successful with mathematical ideas and practices. That is, the prospective teachers in this study disrupted common tropes about mathematics by blurring boundaries between mathematics and disciplines (what counts as mathematical) and mathematics and people (who engages with mathematics). I argue that supporting teachers to see children's mathematical strengths in out-of-school spaces is important for disrupting constraining boundaries around mathematics.

Blurring boundaries around mathematics provided rich possibilities across disciplines, which is conducive to elementary education contexts where teachers explore multiple subjects with their students. Early field experiences in out-of-school contexts provided prospective teachers a space to engage and develop a more accessible, relevant, and connected view of mathematics education, which potentially lends itself well to developing an integrated conceptual approach to STEM (cf. Radloff & Guzey, 2017) during later experiences. Additionally, prospective teachers could observe and establish new ways of seeing children engaging with mathematics outside of classrooms—blurring boundaries between mathematics and people.

These activities have potential to offer multiple kinds of mathematics, connected to other disciplines; for prospective teachers to see themselves as educators who have mathematical worth; and for prospective teachers to see children as people who have mathematical worth.

Our working group served as a space to explore and interrogate dominant narratives about children, mathematics, and mathematics education. Although initially the prospective teachers in this group had experiences with school mathematics as male-dominated, fast-paced, and logically-sequenced, they reframed these conversations to talk about multiple kinds of mathematics connected to multiple disciplines and ways that people might engage with mathematics. I drew on mathematics teacher noticing, broadly conceptualized with mathematizing and mathematical identity narratives, as a tool to engage this work.

As Louie (2017) argued, a cognitive focus on mathematics teacher noticing in research work largely ignores issues of inequity in mathematics classroom spaces. While research on mathematics teacher noticing has largely focused on students mathematical thinking in classroom spaces, an intentional focus on what counts as mathematical and who engages with mathematics provides a more critical lens for teacher noticing. Specifically, mathematics teacher noticing has potential to disrupt the ways traditional mathematics classrooms practices that marginalize some students and ways of engaging with mathematics.

Drawing on identity in mathematics teacher noticing can attend to issues of inequity. For example, "being a math person" is a dominant mathematical identity narrative that limits mathematics education. Through our site visits and following discussions, prospective teachers reframed deficit discourses about children by challenging what it means to "be a math person" through observing children and seeing their play activities as mathematical. Drawing on mathematizing in mathematics teacher noticing can open up the physical spaces that prospective

teachers might navigate to see children engaging with mathematics. In contrast to school mathematics which historically illuminates a limited view of children, our mathematics teacher noticing work in out-of-school contexts provided opportunities to see how children are already mathematical beings, creators, and investigators.

Teacher education programs should create opportunities for prospective teachers to have experiences outside of schools to broaden perspectives on what could be possible in mathematics classrooms. Methods courses might be a space to do this work; however, I encourage teacher educators in mathematics content courses (or other early required coursework) to incorporate early field experiences in out-of-school contexts as part of a connected thread in teacher education programs. Through these activities, teacher educators can support prospective teachers to disengage, resist, and transform dense deficit discourses that construct boundaries around children and mathematics to attend to issues related to identity and power in education.

Finally, I close with further questions for mathematics teacher education to explore. I want to explicitly state that I do not view this process of supporting teachers to notice mathematics in out-of-school contexts as solely a means to communicate that 'mathematics is everywhere.' Although this work contributes to efforts toward a more equitable and just mathematics education, I question how 'math is everywhere' might be read in our own discourses about the role of mathematics in education. That is, how might (re)circulating 'math is everywhere' produce, reinforce, or challenge messages about mathematics?

I pose these questions with a stance that "everything is dangerous" (Foucault, 1983, p. 256). Invoking 'math is everywhere' might reassert justifications for business as usual (i.e., traditional mathematics education), which works against efforts to open up mathematics education through blurring boundaries. I caution a potential danger of how this message might

reinforce messages that suggest a supremacy of mathematics in schools and societies. Furthermore, if mathematics is everywhere and everything, then it is nowhere, nothing, and potentially unproductive. Still, teacher educators and prospective teachers could take up 'math is everywhere' as an opportunity to examine dominant narratives about mathematics from critical perspectives. What other boundaries might we blur in (mathematics) teacher education?

CHAPTER FOUR:

GENDER INEQUITIES: NOT JUST TRUMPED-UP CHARGES

[ESSAY] Searching for Solidarity: Writing about Intersectional Gender Inequities in the Wake of the 2016 Presidential Election Aftermath

"It's just words, folks. It is just words. Those words I've been hearing them for many years."
--Donald Trump, Second U.S. Presidential Debate, 10/9/2016

Unlike President Donald Trump, I take a strong stance that words matter. The ways we treat people matter. Stories matter. Most important to me as an educator, researcher, and person in the world is how we create and (re)circulate discourses to impact each other, both intentionally and unintentionally. I seek to name and disrupt interlocking systems of oppression such as colonialism, white supremacy, and patriarchy. In doing so, I foreground power embedded within discourses that operates to plague our society at a grand scale, including our schools and classrooms. Since the campaigning activities for the 2016 U.S. Presidential Election, gender has become particularly salient as a lens for how I make sense of my experiences as a 27-year-old Latinx woman navigating mathematics education communities as a doctoral candidate and teacher educator at a predominantly white institution.

In Rebecca Solnit's introduction to *Men Explain Things to Me*, she described a vignette that spoke to her repeated interactions with men who acted as if they knew more and dismissed her expertise, regardless of whether that was true. She went on to comment, "Every woman knows what I'm talking about" (Solnit, 2014, p. 4). During the third United States presidential debate of 2016, Secretary Hillary Rodham Clinton called out Donald Trump's repeated derogatory statements and actions toward women and stated, "I don't think there's a woman anywhere who doesn't know what that feels like" (Politico Staff, 2016). As a feminist woman of color, I hear this discourse often and recirculate it myself with intentions to strike resonance

among women in my audience. Recently, however, I began to question my assumptions that (1) all women have a shared understanding of interactions that speak to patriarchy, and (2) all women identify these interactions as problematic signs of injustice that we must fight.

My hesitation stemmed from a range of reactions and feedback to the content of my dissertation wherein I felt, at times, that I was trying to navigate suggestions of minimizing my bias or providing 'better' evidence to explain my experiences as gendered and racialized. I also paused during reflections on the 2016 Presidential Election results as I attempted to make sense of how 52% of White women[31] voters supported Donald Trump in exit poll data. This statistic stung as a jarring, unforgettable reminder of my struggle to find solidarity across intersections of gender and race: a majority of polled White women voters (52%) supported Donald Trump while a majority of polled Latinx women voters (69%) and Black women voters (94%) supported Hillary Rodham Clinton (CNN Politics, 2016).

I want to explain why these values shook me by emphasizing that these percentages only provided part of the picture because each percentage point represents a different number of people. That is, one percentage point of White women voters who supported Donald Trump is many more people than one percentage point of Latinx women voters who supported Donald Trump. I feel quite confident in making this statement based on 2010 Census (U.S. Census Bureau, 2010) data that the population of the United States by race[32] is 196,817,552 White (63.7%), 50,477,594 Latinx (16.3%), and 37,685,848 Black (12.2%). There are nearly four times

[31] Gender and sex are used synonymously (i.e., female and women) in exit poll descriptors (CNN Politics, 2016). I am choosing to use the term 'woman/women' throughout this paper to connect with my own gender identity; however, I recognize that using this term may exclude non-binary people and representations of multiple genders.

[32] These numbers exclude multiracial data and ethnicity (i.e., White alone, Black or African American alone). The 2010 Census defined Latinx (i.e., Hispanic or Latino) as an ethnicity, not a racial identity: "'Hispanic or Latino' refers to a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race."

as many White people as Latinx people (and over five times as many as Black people) in the United States; I would assume that a large share of our electorate is White. This is not to say that internalized white supremacy (and patriarchy) does not exist among some people (and women) of color. Nonetheless, complicating these statistics provided a lens into potential barriers to solidarity. Although I can talk about how 41% of polled women voters supported Donald Trump, I found the intersectional breakdowns quite powerful for examining how white supremacy and patriarchy work together as systems of oppression (see Figure 10). Intersectionality played out through discourses during the presidential election aftermath.

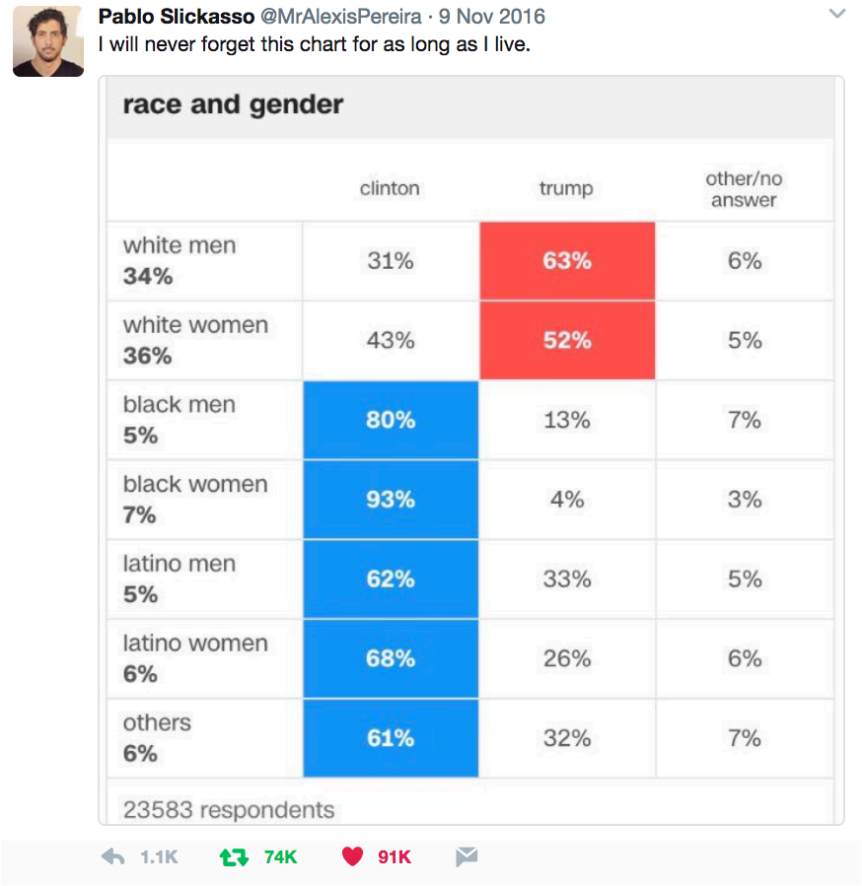

Figure 10. Pereira's (2016) tweet about intersectional race and gender exit poll data.

Three weeks after the election, conservative political commentator and viral online star Tomi Lahren was interviewed by television host and comedian Trevor Noah as a guest on his

late-night program, *The Daily Show*. Tomi is a White woman who grew up in Rapid City, South Dakota. Trevor is a multiracial Black man who grew up in Johannesburg, South Africa. During a conversation about NFL quarterback Colin Kaepernick and the Black Lives Matter movement, Tomi and Trevor talked about the controversy around protesting the national anthem. When asked how Black people should protest their oppression in a 'more appropriate' way that is acceptable to conservative critics, Tomi replied:

> TOMI: I, being a woman, I didn't have rights after Black people, until women got the right to vote, but because I feel like I am a woman, and I'm marginalized in some way, I don't protest my country. I don't see what he's protesting. I would like to know exactly what he is protesting.
>
> TREVOR: So, how do you protest then?
>
> TOMI: I don't protest. Because I'm not a victim. I don't—I choose not to victimize myself. I choose not to make myself the victim. That's the difference.

[Season 22, Episode 30, November 30, 2016]

Through this exchange, Tomi Lahren falsely suggested that women did not have rights until after Black people, which completely disregarded intersections of race and gender by erasing Black women. Somewhere in the back of my mind I heard Sojourner Truth exclaiming, "And ain't I a woman?" Yes, Black women exist. Women of color exist. We are also women.

While I understand wanting to refuse feeling helpless, I do not make sense of what I do as victimizing myself. I am a strong survivor, and "…what you hear in my voice is fury, not suffering. Anger, not moral authority. There is a difference." (Lorde, 1984, p. 132). I must accept, though, that these interlocking systems of oppression are indeed real, pervasive, and strong. I cannot escape them. "Imperialist white supremacist capitalist patriarchy" (hooks, 2013, p. 4), I whisper to myself. I must remind myself that I am not crazy.

After watching this interview, I saw Tomi Lahren as one face within the 52% of White women who supported Donald Trump, propagating messages that (some) women are weak. But I did not know how to talk to someone like her. How could I engage with a person who arrogantly assumed that my actions to acknowledge and disrupt oppressive systems meant that I must victimize myself?

I decided I was going to write a piece about women and mathematics shortly after an unpleasant interaction in December 2015. I will share this story in the following article but admit that this has been a long, painful process. Writing a dissertation section about intersectional gender inequities during this time was like wandering through the darkness of my home at night without electricity: I have a familiar sense of where all the door jambs and furniture are (from my many experiences walking around with light) and can probably navigate the rooms without hitting them, but I still felt anxious and hesitant because I currently felt overwhelming uncertainty. What if I misjudged the distance and was about to run into something? And I could not simply turn on the light switch to alleviate those feelings because the power was still momentarily out. I felt trapped in my own home.

Searching for ways to talk about my experience and unpack that unpleasant conversation, I summoned courage to write after reading Deborah Tannen's (2005) Steps in Analyzing Conversation. One of the steps stated:

> Tape record (with consent) interactions whenever possible. Choose one to study—one that is very familiar or very intriguing, but one preferably with identifiable boundaries and including participants you can later interview. *(Avoid overly personal or emotional interactions, unless you have a special reason for choosing such and feel qualified to deal with the repercussions.)* (emphasis added, p. 211)

Although this advice made me question my qualifications and reinforced my anxiety with talking about gender and mathematics, all the defiant fibers of my being wanted to accept this challenge.

Why include this disclaimer? In my mind, I understood that it was just a warning—one of those "be careful, Lynette" comments my parents would always say to me whenever I was pushing outside the boundaries of my normative box. My *shadow-beast*—the "part of me that hates constraints of any kind, even those self-imposed" (Anzaldúa, 1987, p. 38)—fiercely reacted. Did I have a "special reason" to talk about this interaction? Absolutely. Was I able to "deal with the repercussions" of my writing? I was not sure, but I had been inspired by several scholars and activists to refuse to remain silent. Staying silent does not help. Plus, I did not know what experiences I would need to be qualified, other than putting my work out there and then dealing with any repercussions for the first time. Here I go.

Beyond Hidden Figures: Shining a Spotlight on Constructed Hierarchies of Gender, Age, and Elementary Mathematics

Standing near an open bench, Ann[33] and I looked over the science museum map. This was her first time at this museum, so I briefly described some of the exhibit areas I remembered from my previous visit with four other prospective elementary teachers. We stood adjacent to an open area filled with foam yoga blocks that looked like red bricks. Half a dozen children and their caregivers were stacking and moving the blocks, building towers and walls. An energetic buzz filled the space around us.

"I see matching folders," said a voice behind us, referring to what Ann and I were each holding. A tall White man approached us. He had short brown hair, glasses, and looked a bit older than us, perhaps in his mid-30s. He appeared to be affiliated with the science museum, wearing an official-looking polo shirt and khaki pants outfit with a name tag that said 'JOHN' under the museum logo. "What are you up to?"

Ann and I briefly exchanged a glance. I turned to John and explained that we were visiting the science museum to observe the exhibit areas with a mathematics lens. "We are starting here in the block building area, then will probably move to the Young Scientists room and--"

"Oh, you'll see math in this one area. I won't tell you where, I'll let you find it," John interrupted, with a full smile. He then told us that he was working with a local STEM research group, had a PhD in physics, and was now involved in research on physics education with undergraduate students. "Let me know if you have any questions. I'll be around."

John walked away. Ann and I took our matching teal folders and resumed our activities. We did not know it at the time, but this was just the beginning of our interactions with John. Our

[33] All names are pseudonyms.

encounters with John would, in fact, repeatedly interrupt our work as we tried to observe how children's engagement with the exhibits was connected to mathematical ideas and practices. I left the science museum that day with an unsettling reminder that mathematics spaces are not conducive for women to thrive. As young women with elementary mathematics expertise leading our own work, we were still interrupted during our activities with unsolicited explanations by a man who self-selected himself as our teacher.

About eight weeks later, I facilitated a debriefing meeting with Ann and four other prospective elementary teachers who were participating in my research study, which followed a yearlong voluntary working group that I organized. Our activities, which included monthly meetings and site visits, centered on mathematics teacher noticing—attending, interpreting, and responding to children's mathematical practices in out-of-school contexts (cf. Jacobs, Lamb, & Philipp, 2010), such as the science museum. As a feminist researcher co-collaborating with prospective teachers, I decided to transcribe a major chunk of the conversation among John, Ann, and me at the science museum to discuss with our working group. I did this because I was disturbed by our interaction with John and wanted Ann and I (and the other four prospective teachers) to unpack an example of gendered talk within mathematics spaces. I hoped this discussion would be an opportunity to think about how we might navigate these situations as young women who work in elementary mathematics education.

During this debriefing meeting, we listened to audio recording and read a written transcript. Ann shared with the group:

> I felt like it was very much [John] talking down to us. He's like, '*Well, I'm a male physicist and you're just elementary ed, teaching little kids. You don't know anything*[34].'

[34] I use '*italicized font in single quotation marks*' to indicate when the speaker uses a voice as if they were speaking in another conversation or retelling a previous conversation. In this instance,

> … After all that time that he kept going on about what he knows and then he kept bringing up himself how he didn't know [elementary mathematics] things, but then never started acting like—he always acted like he knew better than us, even saying, '*Well, I didn't even know that* [we teach algebraic ideas in upper elementary grades].' Yeah, because you don't do elementary. [Group Debrief, 1/29/2016]

The goal of this article is to share our story about gender and mathematics—among other intersecting identities (i.e., age, education level, professional expertise)—by unpacking the conversation to which Ann is referring in her reflection. Overall, Ann and I saw John's interruptions and interjections as condescending and dismissive of our expertise in elementary mathematics education. While it might not have been John's intention to make us feel lesser due to our gender, age, and elementary mathematics social positions, I argue that the impact of this conversation from our perspectives should be made visible to recognize and address inequities for women and girls within mathematics and mathematics education spaces. Furthermore, this work contributes to a body of literature seeking to support prospective elementary teachers navigate issues of patriarchy embedded within educational spaces and broader society.

In what follows, I share my positionality as a Latinx woman who navigates mathematics spaces. I connect my story to examples of notable women in mathematics to illustrate a broader issue for women in mathematics. I also provide a brief overview of literature that foregrounds intersectional identities and experiences through feminist perspectives before outlining the science museum conversation. Finally, I close with a discussion that calls for revisiting our current efforts to address gender inequities within mathematics education.

Ann is not referencing a direct quote in her story and instead is rhetorically sharing her impression of what the speaker (John) is thinking, partially based on how his look made her feel. Harré and van Langenhove (1999) refer to this retelling as *rhetorical redescription*.

My Positionality: A Complicated Relationship with Mathematics

I am a multicultural emerging bilingual Latinx woman who is the first in my extended family to pursue a doctorate. My K-12 schooling experiences were in well-funded, predominantly white schools in a large school district in San Antonio, Texas. Beginning in first grade, tracking solidified my subsequent schooling experiences with the same circles of 'high-achieving' children. I do not remember when I first heard the term 'underrepresented minority' student, but I knew from a very young age that I was one. This labeling reinforced a message that I was *exceptional*, like how popular media constructs women of color who are successful with mathematics and science. *Hidden Figures* (2016), for instance, tells the untold story of three 'exceptional' African-American women mathematicians—Katherine Johnson, Dorothy Vaughan, and Mary Jackson—to challenge dominant stereotypes about who can be successful with mathematics- and science-based careers. Despite an increasing number of counterstories of successful trailblazing underrepresented minorities across media and STEM outreach programs, though, women and girls still experience gendered interactions in mathematics classrooms, such as being ignored or undermined by boys (e.g., Langer-Osuna, 2011).

I became increasingly aware of *microaggressions*—"brief, everyday exchanges that send denigrating messages to certain individuals because of their group membership" (Sue, 2010, p. 24)—in my mathematics experiences. For example, during the summer after my sixth-grade year I participated in a mathematics-intensive engineering outreach program. I was acquaintances with an Asian girl in my group who also competed in the same regional mathematics competitions I did. One day, we were leaving the cafeteria with a group of children and she said to me, "You're the smartest Mexican I've ever met!" While it might not have been her intention to hurt me, I was impacted by her declaration, which assumed that people who look like me are

not typically smart. Not knowing how to respond to this statement, I laughed uncomfortably, smiled, and eventually told my parents when I got home. They played it up as a reason why I was special and had to prove people wrong—another incident that suggested I was 'exceptional.' I continued to encounter microaggressions in my college courses, spaces dominated by White men. Eventually, I decided to focus my energy on mathematics outreach activities, which led me to mathematics education where I felt more comfortable and valued. Grounded in my lived experiences, I center on intersectional identities and experiences by drawing on feminist scholarship and positioning theory to guide my perspective.

Foregrounding Intersectional Identities and Experiences

I focus on intersections of identities and mathematics—in particular, women and mathematics—with commitments to a more humanizing mathematics education. I follow mathematics education researchers who have taken up positioning theory in their scholarship to address issues of inequities in classrooms. This work attends to complexities of mathematics identities enacted through student participation in classroom discourses (e.g., Bishop, 2012; Esmonde, 2009; Langer-Osuna, 2011). The focus of my work in mathematics teacher education centers on amplifying prospective teachers' interpretations of their lived experiences, such as the opening vignette and debriefing about our science museum visit. I use positioning theory to unpack these interpretations.

Positioning theory outlines a "discursive process whereby selves are located in conversations" (Davies & Harré, 1990, p. 48) involving communication acts, positionings, and storylines. During communication acts, speakers co-construct meanings through conversational interactions, such as spoken words, gaze, or gesture. Positionings serve as types of rights and duties that speakers draw upon through these interactions (Harré, Moghaddam, Cairnie,

Rothbart, & Sabat, 2009). Storylines are interpretations of communication acts that depend on culturally shared and recognizable narratives. All three aspects of positioning theory operate as an interacting triad; changing one affects the other two.

Davies and Harré (1990) rejected an assumption that positioning is always intentional while also calling attention to impacts of language on people through conversations. In drawing on positioning theory, I am not dismissing people's intentions as strictly irrelevant to conversations about sexism, ageism, racism, and multiple intersecting forms of oppression that seek to dehumanize groups of people and create hierarchies of superiority. Rather, I draw attention to marginalization from the positions of those who are adversely impacted by normative discourses that build up these systems of oppression that plague us all as people living in societies.

I use positioning theory to talk about impact, not intent, to purposefully speak back to harmful discourses that permit dehumanizing assumptions about groups of people to exist and perpetuate. Further, I focus on impact to shed light on perspectives that might be hidden for a variety of reasons, including suggestions that these perspectives are not valid because it was not an intended outcome. Regardless of intention, impact speaks to the realities of how people experience and make meaning (for this paper, I focus on gender). Intersectionality provides a framework for examining these complex interactions across gender and other identity markers.

Building upon decades of work by human rights activists, Kimberlé Crenshaw coined the term *intersectionality* to highlight multidimensionality of the lived experiences of women of color that could not be captured by examining either race or gender alone (Crenshaw, 1991). Socially constructed identities, such as gender, are always interconnected with other identities (e.g., race, class, sexuality, age). Mathematics education researchers have noted the importance

of intersectionality to address inequities that affect historically marginalized students in schools (e.g., Esmonde & Langer-Osuna, 2013; Gutiérrez, 2013). Some mathematics education research attends to microaggressions students experience in these spaces (LópezLeiva & Khisty, 2014; Martin, 2006; Martin & McGee, 2011; McGee, 2013). I draw on intersectionality and microaggressions to uplift non-dominant perspectives, provide counterstories that challenge dominant narratives, and validate situated knowledges and experiences of marginalized people.

Interrogating Hierarchies: Intersections of Gender, Age, and Elementary Mathematics

In what follows, I present the conversation generated during our science museum site visit (12/6/2016) in the main body of text. The entire dialogue is sequenced in order, broken up into shorter segments. Each excerpt is a meaningful chunk that I labeled with a reference to what I am foregrounding. I also included subsequent conversations during whole group and individual interview debriefings in boxed space adjacent to the main body text to visually link our analyses. Drawing on feminist poststructuralist scholarship, I intentionally made these stylistic choices to work within a genre that embodies qualities of ethnographic research. That is, I attempted to "blur traditional distinctions among the write, the reader, the stories and how the stories are told" (Britzman, 2000, p. 27).

Through this narrative, I purposefully foregrounded the perspectives and voices of young women who are future elementary educators with less emphasis on John's perspective. I made this choice because my only interaction with John was through our few conversations at the science museum, and I do not want to speculate about his intentions. I do not intend to demonize John as an individual person but rather seek to validate our interpretations as we made sense of this conversation with him in connection to past experiences and conversations related to

intersectional gender marginalization. This story begins near the end of our time at the science museum.

Ann and I finished our observations and paused to decide whether we should revisit any exhibit. John approached us again. He asked us if we were at the museum for a class activity, and we further explained who we were and why we were at the museum engaging in mathematics teacher noticing.

EXCERPT 1: Being Aged as College Students

John: So you're a graduate student? Or something?

Lynette: Yes.

John: Okay.

Lynette: I'm working on my dissertation and--

John: I see.

Lynette: --so we're going to different locations. They did a math nature walk to start off. We went here for the second one. We're not exactly sure what next semester, the different sites we're going to be. We're going to try to do after-school programs or a playground or come back here.

John: So what is your research that you're coming here to--

Lynette: It's about teacher noticing and how teachers notice students engage in mathematics in spaces outside of the classroom and then how do you use that when you're planning or thinking about math lessons.

John: Okay. [to Ann] so why did you let her talk you into this?

Ann: It's a good thing to have on my resume, and I thought it was really interesting. Like my--

John: You said, "it's a good thing." What's the 'it' in the sentence?

Ann: I mean, to just improve my overall teaching when I become one. So yeah, I mean a big part of being a teacher is always trying to improve how you teach.

John: So are you in undergrad or a grad student?

Ann: Yeah. No, I'm an undergrad.

John: Undergrad in...?

Ann: Elementary ed.

John: Okay.

Ann: Yeah, and my focus is math so it tied in with that.

John: I follow the logic.

Ann: So yeah.

John: Um, there's another set of college students here… So what I want to do is bring them out here and test them on this [torque exhibit] and watch you guys observe them.

> **KATE**: So I don't know if age is—just treating you like, '*Oh, you're just these young people*'—and I feel just how he talks down on everything, it definitely seems a little gendered. A little ageist, maybe. Like, something's going on here. You would think that most people would be welcoming, but he was kind of the whole time not really treating you like [what you were doing] was anything important, which isn't really good at all.
>
> **ANN**: Well, I definitely felt the whole ageist thing when he realized that I was an undergrad, and at that part where I said, "No, we're observing together." …He kind of looked at me like, '*well, you're just her guinea pig, you're just here for her*,' and it's like, no, we're here. We're working together. I don't know. He just really rubbed me the wrong way.
>
> Group Debrief, 1/29/2016

After checking up on us a second time at the science museum, John found out that I was a graduate student working on my dissertation research and Ann was an undergraduate elementary education student. Then, John orchestrated an unplanned demonstration for us to observe his teaching practice with college students visiting the museum. Through this conversation, John's speech acts served as questions to elicit information about who we were and why we were in the science museum. His language use, however, invoked age by stating, "there's another set of college students here," which suggested how he might be aging us—grouped with college students, the population he studies as a physics education researcher. Simultaneously, John assumed the right to self-select himself as our teacher by 'testing' college students at the museum while we observed. This was not part of our plan of work at the science museum.

During our debriefing discussions, prospective teachers invoked narratives about being young women in mathematics spaces. Kate brought up intersections of gender and age, to which Ann elaborated on her experience. John's question to Ann ("why did you let her talk you into this?") suggested a hierarchical relationship between me as the researcher and Ann as a less powerful subject of my work. Ann's rhetorical redescription of being viewed as "just [my] guinea pig" revealed how John's positioning made her feel. Referencing a later part of our conversation (see Excerpt 5), she asserted, "No, we're here. We're working together," then noted her irritation with John and his gendered and ageist talk. This irritation was exacerbated as our conversation with John continued after we observed his demonstration with the college students at the science museum.

EXCERPT 2: "I just wanna move on"

> **John**: Yeah. So math reasoning? You do, you don't? It's also interesting to have college students watching college students do things.
>
> **Lynette**: I don't know. I was going to say at first they're the same. I didn't say it out loud because everyone else was like, "Oh, the right side" and I'm like, '*Oh. Maybe I shouldn't say that out loud then.*'
>
> **John**: That's the common assumption. It is extremely pervasive for people to think that.
>
> **Lynette**: But then when you started talking about torque…I was like, '*Oh, okay. Well…*' I mean--
>
> **John**: She's [Ann] still trying to process the logic of it.

LYNETTE: What feelings did you feel during this?

ANN: I was super annoyed the whole time. Just kinda stood there, had him talk at us the whole time. I was like, '*Okay. Okay. Cool.*' And I think at the point where I said, "I mean, it makes sense," it was kinda like—okay at this point like I kinda wanna move on with the whole thing. Like I—I don't know. I thought that he was very—I don't know if you picked up on him being like very condescending and stuff. And at that point, I was like, you are going to come up with something. Like, you know more than me at this point, and I just wanna move on.

Group Debrief, 1/29/2016

Ann: A little, I mean...

John: That's fine. Questions, comments, concerns?

Ann: I mean, it makes sense.

John: Does it really? 'Cause usually "it makes sense" is a way of saying '*I don't really get it yet, but I don't want to have you make me feel dumb for not getting it.*' But you're not dumb, let's be clear. I just work in education so I'm aware of how these things bear themselves out. What did I tell you guys I was earlier? I told them [college students] I was a physicist. I told you guys I was in education.

Lynette: Yeah.

John: Both are true. It's just I'm confusing myself on who I've told what. I'm a physicist who studies education.

Again, John continued a storyline that positioned us as college-aged students under his purview as he commented that it was "interesting to have college students watching college students do things." As I began talking about my thinking and sense making, John interrupted to comment that Ann was "still trying to process the logic," which positioned her as needing help and John as her teacher. Through this exchange, John assumed rights as a knowledge bearer and responsibility to educate us. Hesitantly, Ann took up this positioning but then rejected it and stated, "I mean, it makes sense," in response to "Questions, comments, concerns?" John subsequently rejected Ann's assertion ("Does it really?"), questioning her self-assessment and understanding with an assumption that she was trying to avoid feeling dumb in front of him. He proceeded to talk about his experiences as a physics educator and asked again whether we had questions while Ann remained silent.

Ann's reflections during our debriefing elaborated on her silence. Although John assumed rights and duties to be an expert teacher, Ann never asked to be taught and ultimately rejected this positioning in our conversation with him. Despite being educators ourselves, John's

positionings and produced storyline did not make it possible for him to see us as sharing (or even having different) expertise. Consequently, Ann (and I) felt that John's interactions with us were condescending because he talked at us and dismissed our elementary mathematics expertise. Ann felt that whatever she offered in the conversation would elicit a response from John that maintained him knowing "more" than her. Recognizing this dynamic in the moment, I took a lead to foreground our elementary mathematics expertise in the next part of our conversation.

EXCERPT 3: Showcasing Elementary Mathematics Expertise

> **John:** Thoughts, questions, comments, concerns? You don't care at all 'cause they're college students and not elementary students? 'Cause that's valid.
>
> **Lynette**: It is definitely different. So if I were to look at this [torque exhibit] without having that whole demonstration, I would think about--well, they're equally spaced apart locations and so you can talk about things in terms of fractions or thinking about distance and that relationship.
>
> **Ann**: Yeah.
>
> **Lynette**: Proportional reasoning--
>
> **John**: So the other thing I often do--when they're younger, what I'll do is this. [walks to exhibit] I'll start with a question of--so I'm going to put this here: [places weight] How many do you think you have to add to this side? And they guess, and I have them try. And eventually, come up with it's balanced with one, right? Okay so then how many do you have to do with this [places weights] to make it balanced? And eventually they figure out it has to be two to be balanced. And then, I do a hard thing, right? [places weights] How many do we need over here? The answer is?

John completely moved on from 'teaching' Ann despite questioning whether she understood the science in his previous demonstration. He suggested that we might not care about observing "college students and not elementary students" and interrupted my comments about what I saw as an elementary mathematics educator to conduct another demonstration, one that he

does for younger children. Through John's redirection, he continued to advance a storyline with us as his students and not as people who have knowledge and expertise as elementary mathematics educators. Like the college students from his first demonstration, we then became the people he tested as a teacher soliciting responses to his posed questions.

EXCERPT 4: Defending Elementary Mathematics Education

> **John**: First of all, getting them to understand that it's an additive relationship is in itself non-trivial. And then the fact that they have to do the addition in their head, depending on their age is also kind of a problem. Right? Not having 1 + 2 in front of them makes it harder to do.
>
> **Lynette**: Yeah, 'cause I can also see taking a step--even middle grades--'cause the balance beam is used as a metaphor for equations, so when you're--
>
> **John**: Not in elementary school, right?
>
> **Lynette**: --composing and--well, similar. You're composing, decomposing numbers like you're putting numbers together so you can do--
>
> **Ann**: I mean, yeah in elementary school a little bit. Like fourth and fifth grade when you start talking about having variables and solving for variables. What you do to one side of the equal sign, you can do the same to the other--
>
> **John**: We do this in fourth and fifth grade now?
>
> **Ann**: Yeah. Yeah.
>
> **John**: Feels early. 'Cause I didn't do algebra until like eighth grade. Seventh grade. I suppose question mark counts as a variable though, which is what you see in elementary school, right? 3 + ? = 7. Those kind of things.
>
> **Lynette**: Cool.

ANN: After all that time that he kept going on about what he knows and he knows and then he kept bringing up himself how he didn't know things, but then never started acting like he didn't—like, he always acted like he knew better than us, even at this time: '*Well, I didn't even know that.*' Yeah, because you don't do elementary.

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In the moment, this part of the conversation felt the most intense to me. While John's comment ("Not in elementary school, right?") might have been a clarification in response to my mention of middle grades, the way Ann and I took it up and responded reflected how we felt about his positioning of us as elementary mathematics educators. In response, I spoke about composing and decomposing numbers, and Ann broke her silence to talk about algebraic ideas in elementary grades. Ann positioned herself as having elementary mathematics expertise, and took on a duty to inform John that equations are indeed relevant to elementary education. John questioned this assertion, though, by using his own schooling experiences ("I didn't do algebra until like eighth grade. Seventh grade.") as an exemplar. He conceded that algebraic ideas in elementary mathematics might not have symbolic representation of variables as letters (e.g., x and y) and instead use a question mark to "count" as a variable.

Ann challenged the dominant storyline of John as our expert teacher by introducing another storyline where John was a novice in her expertise of elementary school mathematics. Her reflection suggested frustration with the way John continued to center the conversation on his knowledge as superior to our knowledge. Ann pointed out that John's self-positioning of superiority came through even during the moment where he did not know that children engaged with algebraic ideas in elementary school. Ann's decision to speak back was in part due to her frustration and annoyance with John's dismissal of elementary mathematics. I was also frustrated and annoyed with our conversation, ending this topic with one word, "Cool." Nearing the end of our conversation, John tried one last time to 'help' us.

EXCERPT 5: Rejecting and Repositioning

> **John**: Anything else I can help with?
>
> **Lynette**: No, I think we've seen a lot. So that's the thing with the noticing is there's so much to notice and that's part of what we're trying to experience—you're in a classroom,

there's a lot of things that you could look at. Or you're in a space that's not the classroom and there's a lot of things you could look at. How do you take a math lens to that?

John: So is there any particular reason--so you described it as you're looking at noticing, teacher noticing.

Lynette: Mm-hm.

John: But you're actually just telling me is you're going to informal places, which is a very different environment with very different training of teachers or leaders in those environments.

Lynette: Right, so the identity of teachers is not restricted to the classroom though. So part of what--at least what I see, is this teacher identity and so they are developing their professional skills of '*I'm not just a teacher in the four walls of my classroom, but there are other places that are rich for mathematical ideas*.' Connections. That's very big in Common Core, especially talking about connecting to students' experiences outside of the classroom.

John: So now I'm confused. [to Ann] You're here because she's observing you doing those things?

Ann: No. We're working together to observe these things.

John continued the dominant storyline of expert teacher seeking to help us. I rejected his offer and elaborated on the complexity of our teacher noticing work in the science museum by establishing a parallel to the complex work that teachers engage in classrooms. In this turn, I repositioned us as people who have professional expertise as mathematics educators. John responded by redefining and explaining the work that we are doing in "a very different environment with very different training of teachers," ultimately questioning the connection I made between being an educator in the science museum and being an educator in the classroom. Through further discussion, John asked Ann if her presence was for my research. He previously offered this positioning of Ann as a research subject under my observation near the beginning of

this conversation. This time, though, Ann rejected John's positioning and repositioned herself as an equal partner by stating, "No. We're working together to observe these things."

In response to John's initial positioning of Ann as my research subject (see Excerpt 1), Ann first mentioned building her resume but then commented that she "thought it was really interesting" before John cut her off. She then stated her long-term goal of improving her teaching practice through this project, repositioning herself while centering her agentive power. This time, though, Ann strongly asserted an identity of elementary mathematics expertise as not solely a research subject but also someone with whom I worked alongside. She spoke up for herself to reject John's suggested hierarchy between us and firmly stated that we were both contributing during our observations. In the moment, I read from Ann's tone that she was annoyed and did not want to be part of this conversation any longer as John pressed on.

EXCERPT 6: "I also have a PhD" (but can he understand?)

John: Right. [to Lynette] But you're saying you're looking at teacher noticing. Who are you watching watch the children?

Lynette: Them. So it's a dual thing. It's professional development so that's why Ann mentioned "on my resume" [earlier in the conversation]. So this is professional development as we are trying to learn to be better teachers, but also for me the dual part is as a researcher, how is it that I'm working with teachers? And also myself, because I'm also learning to notice these things in different spaces outside of the classroom. [pause]

LIV: Just pretty much off topic from the whole mathematical noticing thing, but just on line 97 and 98 ["I also have a PhD…"], I just feel like, you don't need to say that. I don't know why would he say that? That's all…

ANN: Yeah. Well and the fact that he was like, "I also have a PhD. I understand," it's like, well, you don't, though. [GROUP laughs] Clearly in this interaction you do not understand what we're doing here.

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I could spend a lot of time talking about my dissertation, but I don't want to hold Ann up. I know she has another place to be.

John: I also have a PhD. I understand. I know exactly what you're talking about. I know where you are in life. It wasn't that long ago for me.

Lynette: But thanks for, you know, the demonstration and checking in on us and--

Ann: Yeah.

John: Just trying to be helpful. As you described it, right, you're not just teachers inside four walls. I don't--I come here partly as a teacher, right? And because I have the skills that I do that doesn't mean I'm just teaching that one, I'm also doing what I can with everybody I see walking in the door. Plus, most of my research work is college-level students so you guys are more in my wheelhouse than others.

Lynette: Okay, thanks John.

Ann: Thank you.

John: Yup, see you later. I'm here most Sundays.

Again, I explained to John how our teacher noticing work was complex and collaborative. During a pause in the conversation (right before I said, "I could spend a lot of time talking about my dissertation…."), John gave me a look that suggested he was going to follow up with another question. Before he could speak, I made a move to end the conversation. My comments positioned Ann as being unnecessarily inconvenienced by our current discussion where I explained my dissertation work to him. John responded, "I also have a PhD. I understand," positioning himself as an expert—someone who has already gone through the doctoral dissertation process with wisdom to offer. Despite only 'knowing' that I was currently working on my dissertation (and not much else), John claimed this wisdom by telling me, "I know exactly where you are in life." In closing, John emphasized his helpfulness to us during our science museum visit as part of what his duties as an educator, reinscribing the dominant

storyline of him as our expert teacher. He invoked age as part of this storyline by reminding us that "most of [his] research work is with college-level students so [we] are more in [his] wheelhouse than others."

I always intended to audiorecord my site visit interactions with the prospective teachers while we navigated the museum to capture our conversations regarding what we noticed about children and their mathematical practices. I was not expecting, though, to be followed and interrogated repeatedly during our visit. It may be possible that this happened because we were at the museum on a less-populated Sunday afternoon; however, that circumstance alone did not explain the condescension we felt as young women studying elementary mathematics and the anger we expressed following the interactions. Furthermore, John's final comments about us being "more in his wheelhouse than others" suggested that he specifically attended to us (and the college students he showed a demonstration) as museum visitors who he could teach (as opposed to other guests). This storyline and related positionings persisted, even though Ann and I were also educators and had expertise in elementary mathematics education.

> **ANN**: I mean, I think that he was clearly a person that didn't understand the importance of elementary math and like how much it actually affects every day life and stuff like that. Like, he clearly just did not get it. So I don't know. I was like ready. I was ready to fight. I was like ready to defend. [laughs] He was so annoying. I felt bad for you [Lynette] because he was like so rude about the whole thing. But yeah. I mean, like he clearly just didn't get how important elementary math is in everyday life and how much you use it and yeah. I don't know. He was annoying.
>
> Interview, 1/28/2016

From Ann's perspective, John did not understand nor appreciate elementary mathematics as valuable, and thus, "was ready to fight" to defend her area of specialization as a prospective elementary teacher. I already knew Ann was irritated by our conversation with John; however, I was struck by her assertiveness during this interview because it was not her typical demeanor.

She usually had a quiet presence in our group meetings—rarely ever the first person to start a group discussion, at times hesitant when asked her thoughts—but she was confident and animated in this interview talking about our conversation with John.

Similarities and Nuances in Interpretations

Overall, reactions across prospective teachers who were not in the conversation also validated our interpretations of reading age, gender, and elementary mathematics narratives in this interaction. Although the audio recording and corresponding transcript might not entirely capture the intensity of living this conversation in the moment (e.g., feeling vibes, non-verbal gestures), our shared similar interpretations of these narratives were recognizable through resonance. We drew on previous experiences and conversations related to intersectional gender marginalization and made sense of this specific interaction with that knowledge in mind. For example, when I asked the group if they had any other personal stories about gendered or ageist interactions, Ann described one of her experiences visiting the university mathematics tutoring center for one of her undergraduate mathematics courses.

> **ANN**: There was a guy who was working there—I'm assuming that he was undergrad. I think all undergrad works there—but obviously, I think you have to take through Calc 4 to work there—it's like, obviously he was much more advanced in math than I was, happened to be a guy, and he came up to me. I was like, '*Oh, I need help on this*,' and he looks at me and starts laughing. I was like, '*What?*' he's like, '*This is so simple.*' Okay, well clearly not because I didn't know how to do it, and if I did—like, I don't know. I was like, '*Thanks for laughing at me, though?*'
>
> Group Debrief, 1/29/2016

Ann read her interaction as gendered when the tutor, who was a man, laughed at her request for help on a mathematics problem and stated, "This is so simple." Not only was this story a personal experience for Ann as a young woman, but it is also a recognizable storyline that speaks to marginalization of women in mathematics spaces at a larger scope. Beth replied to

Ann's story by sharing that she had similar interactions if she went to the tutoring center in the mathematics department—adding, "I don't ever think I saw a female work there,"—but had better experiences with the tutoring centers in other buildings on campus.

Although all five prospective teachers and I identified as women, not everyone shared the same interpretations of the science museum conversation during initial reading. When Ann and I discussed our perspectives during the group debrief, Kate and Liv immediately offered their agreement with reading John as condescending through his gendered talk while Beth remained silent. I asked Beth what she thought, and she replied, "I guess I didn't pick up on that, but now that I'm looking at it, like his parts are larger and you guys are just like, '*Okay*,' and he like continues talking." John did indeed speak 673 words across 31 turns during this conversation, which was slightly more than Ann and I combined (657 words across 33 turns). Beth agreed that John seemed condescending during some parts of the conversation, but hedged her interpretation by stating, "I guess now I'm like kinda interested in having an interaction with him, and like, how does he make the little kids there feel?" While Beth acknowledged our gendered interpretations of this conversation, she was also somewhat resistant to make these interpretations the only possible readings or perspectives.

> **BETH**: I would like to, in a way, see like a male's perspective of this—like have one being here with us and getting their opinion because they might see it differently. But I don't know, that could be stereotyping part of identity that we talked about.
>
> Group Debrief, 1/29/2016

Beth's words captured the epitome of using positioning theory in this article: multiple storylines might be invoked and interpreted from different perspectives that are shaped by different previous conversations. John's interpretation of the kinds of positionings and storylines in play during our conversation might be quite different, just as Beth's initial interpretations

were. Beth's reflection spoke to this complexity as she proposed having a "male's perspective of this [conversation]" while also commenting that doing so might stereotype men as all having the same perspectives (e.g., being blind to gendered talk).

I highlight Beth's reflection to emphasize that, regardless of well-meaning intentions, John's words impacted both Ann and I as we read age, gender, and elementary mathematics narratives in our conversation. Furthermore, not all women (or any group of people connected by an identity marker) might interpret gendered talk in the same ways. What is important for this argument, though, is whether Ann's and my interpretations and retellings of our experiences are validated as possible interpretations. In closing, I discuss implications for mathematics teacher education to support young women to navigate gendered interactions and call for mathematics educators and stakeholders to revisit our current efforts to address gender inequities within mathematics spaces.

Discussion

In this article, I unpacked a conversation at the science museum to share a story about gender (with intersections of age, education level, professional expertise) and mathematics. John's positionings of Ann and I throughout our conversation speaks to marginalization in multiple interconnected ways: as *young people* who are devalued as not having enough expertise, as young *women* in spaces historically dominated by men, and as young women *elementary mathematics educators* who are devalued in favor of mathematicians who work with more 'advanced' (i.e., abstract) mathematics content. During final interview member checks, I asked each prospective teacher what would be important for educators and researchers to learn from this science museum conversation and debriefing. Liv said to me:

> I guess like people will always be able to argue that he never said, '*Hey, you two females'*… people can always argue that it's just our interpretation because we have

> negative experiences of men looking down on us and when they say anything remotely disrespectful we immediately assume it's because we're females. [Interview, 4/29/2016]

I argue that the impact of this conversation from our perspectives as young women who study elementary mathematics education should be made visible to recognize and address inequities for women and girls within mathematics and mathematics education spaces. This work contributes to a body of literature seeking to support prospective elementary teachers navigate issues of patriarchy embedded within educational spaces and broader society. I hope that sharing my experience navigating and debriefing this gendered interaction with prospective teachers offers an example of how mathematics teacher educators might confront sexist interactions to facilitate critical conversations about larger systems of privilege and oppression.

I also reiterate that I am not seeking to focus on John as an individual man. Interestingly, John's assumption that (young women) elementary educators lack 'strong' mathematical knowledge aligned with dominant storylines in mathematics education research and policy documents (e.g., Ball, 1990; Borko et al., 1992; Conference Board of the Mathematical Sciences, 2012; Ma, 1999; Mewborn, 2001; National Research Council, 2001). In other words, deficit framings of elementary mathematics teachers are visible in broader mathematics education discourse. These framings are not isolated from intersecting ageist and sexist systems of power, which operate on dominance of older men through the oppression of younger women.

Furthermore, I want to address any responses along the lines of '*but #NotAllMen*[35] *circulate gendered or sexist talk*' by reiterating that this article is about impact, not intent. Regardless of John's (or any man's) intent with his words, this article elaborated on how Ann

[35] #NotAllMen is a hashtag that refers to a common phrase ("Not all men are like that") that represents "a stock male response when women [talk] about their oppression" (Solnit, 2014, p. 124) used to derail conversations about sexism and counter generalizations about men. The hashtag, reappropriated by feminists, is often used as a form of satire.

and I took up our conversation with him. Our interpretations were embodied and mediated by past conversations and experiences. Centering perspectives of young women speaking with a White man in a STEM space highlights the complexities and importance of this situation regarding intersecting narratives about young women navigating traditionally masculine STEM spaces dominated by men.

In my continued conversations and storytelling of this conversation, anger has been one common emotional response. However, there is simultaneous value in how Ann had an opportunity during this challenging encounter to enact an identity of expertise as an elementary mathematics educator. Ann asserted her expertise through her voiced rejection and repositioning in response to John's implied hierarchy of me as a researcher and her as solely my subject of study. One-dimensional stories of women, young women, and young women elementary educators in STEM as needing help or lacking expertise allow people like John to enact these positionings and storylines.

Finally, I suggest that elementary teacher education should provide opportunities for prospective teachers to share their stories and gendered experiences with attention to intersections of age, gender, and connected disciplinary narratives (in this case, mathematics). Inviting prospective teachers to discuss gender in STEM environments complicates and pushes back on narratives of 'progress' suggesting that we have fixed gender issues in mathematics education. While efforts from outreach programs and higher education might indicate that more women entering STEM-based majors, STEM spaces are still not conducive for women to thrive in complex ways. This story pointed out nuances in marginalization for women: age (and assumed lack of expertise), and elementary education (and dismissal of elementary mathematics as valuable).

CHAPTER FIVE:

SPEAKING BACK

[ESSAY] Offering Messy Stories to Resist Clean Myths

"We need to be careful with 'I don't care' [about 'Where's the math?']," cautioned the older White woman. My mind went racing. My listening started to fade out as I heard foggy sounds coming at me. I have seen this before—words of caution by older (White) people telling me how I should feel and express emotions. This time, though, I was not intimidated by my status on the hierarchy as a student and hers as a tenured professor.

After she finished speaking, I replied, "As a woman of color navigating predominantly white institutions, there are only so many things I can care about." I went on to clarify my meaning in not caring about entertaining questions of 'Where's the math?' because that kind of question—and intended dividing practice[36]*—was entirely irrelevant*[37] *to the humanity I am fighting for in mathematics education spaces.*

Throughout the movie *Hidden Figures* (2016), there was a buildup of anticipation as Katherine continued to encounter racial (micro)aggressions[38] from her colleagues. She navigated these normalized daily assaults with grace and obedient silence. One day, however, Katherine's boss publicly confronted her about where she had been spending her time while not at her desk, and she boldly responded that she had been forced to use the 'colored' restroom in a building over half a mile away from her work space. She continued to voice her experiences as the only Black woman working in a unit of White men: abiding by a dress code for women but not being

[36] A *dividing practice* is a process of objectification by which a human being is "divided inside himself or divided from others" (Foucault, 1983/2001, p. 326), constructing divisions between normal and abnormal.

[37] Danny Martin told us at a graduate student luncheon that he stopped entertaining questions of 'where's the math?' with this reasoning (personal communication, December 10, 2014). I imagine he would have received a different response than I did at this table.

[38] I placed 'micro' in parentheses as a nod to microaggressions literature that I have cited throughout this dissertation; however, I often view these interactions as aggressions that are not 'micro' because they are tied to serious legacies of assault.

able to afford a white pearl necklace, seeing her co-workers put out a separate (and non-functional) coffee maker labeled 'colored' just for her, and not having a bathroom to use in the building. Speaking is important. My role as a mathematics education researcher is to tell stories that speak back to acts of violence (e.g., psychological, emotional, physical) within mathematics spaces. Through this storytelling, one act of resistance is to choose not to engage clean myths by offering messy (and perhaps more human) stories about people.

I have begun this work through how I share stories about my own experiences navigating an academic life. First and foremost, I am indebted to women of color, both within academia and at home, who sustain me with their labor and love. A couple years ago, I mentioned to a professor that I aspired to be like Julia Aguirre and Rochelle Gutiérrez. The professor responded, "Well, that's a pretty tall order," referring to their high esteem in mathematics education research communities. Yes, absolutely. My role models will be exceptional. To be a brown woman in academic spaces, you must be amazing to exist. That also meant *I* had to be amazing to exist; there is no tolerance for mediocrity for people who look like me. No pressure, right?

I was recently reminded of this truth when one of my mentors announced to a room full of faculty, PhD recipients, and our families that I was the first Latina to graduate with a PhD in mathematics education at Michigan State University. *The first.* Wasn't that title reserved for important people who accomplished great things in the past? In that moment, my existence made perfect sense. *En la lucha.*[39] I always thought I was following the paths paved by trailblazers, but I never considered myself as a trailblazer, also. I suppose some paths were already paved and my job was to make sure they did not fade away for those who follow us. I never asked to carry this

[39] In the struggle.

weight. At the same time, though, it really is a shared burden—a little lighter to carry among all of us fighting for our liberation.

When I walk into spaces with brown children, they stare at me—eyes lighting up the room because someone who looks like them is doing 'great' things. *Epitome of success*, according to my family and others who show me off, like a trophy. (If only they knew their National Hispanic Scholar was labeled 'at-risk' in her undergraduate Honors college program.) Anything I said, these children seemed to hang on to every single word. I recognized that feeling, though. Sometimes I am the brown child who does that too, listening to brown women professors: I hang on to each word. They are exceedingly brilliant. We are brilliant. But our stories of resilience and success are simultaneously stories of pain. Single stories erase this messiness. I refuse to be defined as 'marginalized' in totality; I am strong. I also refuse being 'exceptional' as a rarity; I do not believe human beings are as different as we might think. I am everything—my complex and contradictory self—all at the same time. And so is everybody else.

> All of these stories make me who I am. But to insist on only these negative stories is to flatten my experience, and to overlook the many other stories that formed me. The single story creates stereotypes. And the problem with stereotypes is not that they are untrue, but that they are incomplete. They make one story become the only story. (Adichie, 2009)

I understand the allure of mitigating messiness in favor of a consistency that lacks contradictions. Consistency is controllable, possibly predictive. But messiness is realness, resonance that beautifully connect us in powerful ways. A density of messy stories make it difficult to uphold clean myths.

When I was attended an Ethnography Forum hosted by the University of Pennsylvania Graduate School of Education in spring 2016, I met many literacy scholars engaged with interesting ethnographic work. During a luncheon 'fireside chat,' I shared my interests in identity

and mathematics education in a small group. An older White woman replied, “Girls and math? I thought we were past this!” Granted, I was in a room full of people who did work outside of mathematics education, but it made me confront the pervasiveness of a storyline that we are “past” inequities, especially because we could point to all these wonderful STEM outreach programs and quantities that suggest we are improved.

But are we *really* past this? As I argued in my second article (pp. 83–105), gender inequities are not ‘solved’ for mathematics and STEM spaces; they are subtle, intersectional, and often hidden from the spotlight. This is a primary reason why I feel strongly compelled to challenge the intense emphasis on STEM outreach for women and people of color; not because I think we should not try to pursue STEM but because there is much more work to be done for STEM spaces to be conducive for women and people of color to thrive. I call for messy stories so that it becomes more difficult to tell clean myths with credibility and so that our stories of simultaneous success and struggle can legitimately exist without dissonance.

Complex and Contradictory Conversations: Interrogating Dominant Narratives within Mathematics Education Discourse

> It's important to not really focus on identity too much because in society we focus on identity so much… just push those identities aside and really focus on having all your students be successful no matter what their identity is and make sure [identities and stereotypes] don't get in the way of what you think about students.
>
> [Ann, Interview, 1/28/2016]

> I feel like now, especially in modern day, we all talk—like people act like since we've now addressed that there's gender inequality we fixed it, but I mean, this [gendered talk] just shows that whether you—you might not even notice it happening where—yeah. But I mean, it's still there.
>
> [Ann, Interview, 5/3/2016]

Much recent attention in mathematics teacher education research has focused on (mostly) White prospective teachers confronting issues related to privilege and oppression in schools (e.g., Bartell, 2012; Bieda, 2016; Melgar & Battey, 2016; Ullucci & Battey, 2011). One commonly circulated narrative about White prospective teachers (and prospective teachers, in general) in mathematics teacher education communities is that they refuse to engage or acknowledge these issues in complex ways and are often resistant to these conversations (e.g., Koestler, 2016). While I have had similar experiences as a mathematics teacher educator, I have also recently revisited the ways I frame my experiences with prospective teachers to foreground the complexity and messiness of their thoughts and experiences.

The purpose of this paper is to critique the ways mathematics teacher education research often circulate problematic ideas about prospective elementary teachers and to offer an example of using an idea mapping task to support prospective teachers to interrogate limiting dominant narratives in mathematics education discourse. I highlight a collaboration among five K-8 prospective teachers in a working group that I facilitated focused on learning to notice children's

mathematical practices in out-of-school contexts. During my time as facilitator of this working group, I noticed at times that the prospective teachers and I would say and write statements that seemed contradictory. For instance, across multiple discussions and written reflections, prospective teachers in this working group often called on a meritocratic storyline that '*If you just work harder you can get ahead in mathematics*.' This storyline is likely related to an idea that mathematical concepts continuously build upon each other across our school curriculum, and thus, there is a trajectory to follow to 'get ahead' in the subject by an assumed meritocracy that rewards hard work with more mathematical opportunities.

Ladson-Billings and Tate (1995) offered Critical Race Theory to the field of education as a way to challenge claims of neutrality and meritocracy. Following Carter (2008), I define *meritocracy* as a system whereby "one's social and economic mobility are achieved primarily through individual effort and hard work" (p. 466) regardless of any social identity markers, such as race, class, and gender. A meritocratic view on education in the United States "represents an evolution of racism meant to maintain its deep roots by focusing on the success of individuals" (Laughter, 2013, p. 14). Thus, a myth of meritocracy ignores systems and institutions to foreground and blame efforts (or perceived lack thereof) by individuals.

From these prospective teachers' reflection, I found this meritocratic storyline particularly interesting because nearly all of them also shared stories about mathematics tracking in their schooling experiences. Tracking structures make a meritocracy seem difficult to achieve, though, because: (a) it is uncommon for some students to change tracks and move up this constructed hierarchy (e.g., Mickelson, 2003), and (b) some students' parents or guardians can contest and change tracking placements (e.g., Loveless, 1999). Yet, some teachers maintained a meritocratic storyline even with their own tracking experiences, largely attributing successes to

individual hard work with little questioning of larger structural issues in mathematics education.

In addition to tracking in schools, prospective teachers shared stories of putting dimensions of identities aside and treating students as individuals, such as Ann's first interview comments above (1/28/2016). An individualist ideology contributes to a myth of meritocracy because of an assumption that individual efforts alone explain success, disregarding ways that racism and sexism (and white supremacist patriarchy) is embedded in our society to actively marginalize people of color and women.

In mathematics classroom spaces, teachers and students often (re)circulate discourses of meritocracy, which consequently dominate our largely narrowly-defined ways of accepting certain kinds of mathematics—Eurocentric, proof-based, and masculine—as a problem that marginalizes certain groups of people (e.g., people of color and women) in these spaces. Consequently, much of the conversation may solely boil down to perceptions of an individual student's effort as explanations for mathematics learning: *If you just work hard(er), you'll be able to succeed in mathematics.* These views on individualism are dangerous because they absolve responsibility from teachers and schools without much critical consideration of how racism and sexism operate to uphold a discriminating functioning of our schooling systems.

I must admit that as a teacher educator I have grown frustrated with continually seeking to disrupt a myth of meritocracy as a dominant narrative within teacher education spaces. At the same time, though, I could understand a desire to dismiss identity markers, especially to reject deficit narratives that falsely characterize women as inherently terrible with mathematics. I had previously circulated that perspective when I was an undergraduate mathematics major who was a 'successful' woman of color dispelling stereotypes. A myth of meritocracy is one example of a contradictory idea that is common in mathematics education discourse. Contradictions are the

focus of this paper.

I chose to open with Ann's words as an invitation to consider how prospective teachers and teacher educators might engage with seemingly contradictory ideas. One interpretation of these two interview excerpts might be that Ann changed her perspective over time and her later comments shed light on a 'truer' view of her current thinking and who she has now become. This interpretation is a commonly shared story in teacher education research that privileges goals for prospective teachers to become different (and better) kinds of people with teacher educators as the heroes responsible for transforming problematic beliefs.

Given my close interactions with Ann and the other prospective teachers in this study, however, I offer another interpretation that it is possible that Ann might have said either statement at either time, depending on the specific contexts of the conversations. That is, Ann could simultaneously care about mitigating issues related to gender inequities in mathematics education *and* maintain an identity-blind approach to education where teachers and students "push those identities aside" to achieve success. This interpretation is grounded in a complex view of (prospective) teachers as messy human beings who might, at times, hold simultaneously contradictory ideas that are more nuanced. I find this interpretation more educative.

Like Ann, prospective (and practicing) teachers might express contradictory views about mathematics and identity. Mathematics teacher educators could choose to frame these contradictory views as an opportunity to engage deep philosophical questions with prospective teachers rather than a problem that must be eradicated (by mathematics teacher educators). While I continued to facilitate the working group, I grew to appreciate contradictions as a potential entry point to tease out complexities in the ways we talked about mathematics and mathematics education. Subsequently, I wondered what might happen if we put a spotlight on these potential

contraries during our working group activities. That is, what do we say when considering two ideas together that seem to conflict? How might we make sense of and respond to contradictions? I chose to center contradictions during an idea mapping task, which I offer as a practical tool for mathematics teacher educators to engage with prospective teachers.

I argue that this exercise engaging with contradictions in our own thinking provides prospective teachers opportunities to tease out nuances for articulating differences and reconstruct ideas that generate new perspectives for teaching and learning mathematics. Despite a desire to eliminate contradictions in logical reasoning, I take a stance that contradictions are not necessarily bad, and therefore, I encourage educators to embrace contradictions as integral to the complexities of teaching practice and continual professional development. In what follows, I connect this work to related literature in teacher education, provide a description of an idea mapping task, share examples of complexities and contradictions we explored, and close with a discussion of implications for mathematics teacher education.

Resisting Simple Stories of Teaching and Learning Mathematics

Researchers have previously argued for embracing contradictions in approaching educational work by resisting all-or-nothing type characterizations of people. Hogan (2008), for example, described a 'tale of two Noras' by outlining how a Yu'pik student, Nora, was differently constructed by her teachers as a mathematics learner. In one context, Nora was described by her teacher (a Yu'pik woman) as a "genius in math" (p. 102) who was shy but had self-confidence and would help other children with their mathematics work. In another context, Nora was described by her teacher (a White man) as "a D+ student, but a *hard*, *hard* worker" (p. 103) who often quietly worked alone. While Nora was the same child, Hogan (2008) argued that her performance and how she was constructed as a mathematics learner in the classroom was

largely shaped by different contexts. One context was student-centered and culturally relevant and the other was teacher-centered and focused on Western mathematics. The author pointed to sociopolitical considerations across gender and power as part of the ways Nora's teachers constructed her in vastly different ways as a mathematics learner.

Another example of nuanced examinations of complex interactions in mathematics classrooms is Wood's work on mathematical micro-identities. Wood (2013) drew on positioning theory to offer a framework of *micro-identity*, "the position of a person in a moment of time" (p. 780). Mathematical micro-identities involve positions related to mathematics and engagement with mathematics at particular moments. This perspective challenges an assumption and desire for consistency across identity over time, which requires a dismissal of any contradictory moments that might not fit an ascribed storyline. Wood (2013) provided an analysis of one fourth grade student, Jakeel, and his enactment and shifts of three mathematical micro-identities during one lesson: mathematical explainer, mathematical student, and menial worker. Wood's study foregrounded connections between Jakeel's multiple mathematical micro-identities and the dynamic social and physical contexts within the classroom. Furthermore, she offered a non-linear perspective on changes or differences in identities for students.

Focusing on the complexities of teaching practice, Crespo (2016b) argued for embracing the contraries of mathematics teaching in teacher education. Rather than characterizing a single teacher's practice as solely traditional or solely reform, Crespo drew attention to tensions regarding representations of practice (Grossman et al., 2009) as complex and conflicting. She proposed an alternative strategy for analyzing video of teaching practice where she edited episodes of a one teacher's practice, creating one version of 'reform' teaching and one version of 'traditional' teaching. Through engaging contradictory teaching practices, Crespo disrupted a

false dichotomy often constructed to label teachers as either reform or traditional rather than taking up a more complex and nuanced view of mathematics teaching. Furthermore, this type of engagement provides alternative framings of oversimplified deficit discourses about teachers and students.

These three examples engaged contradictions to foreground complexities in mathematics teaching practice. Hogan (2008) and Wood (2013) provided evidence and theory with implications for teachers and researchers to consider complexities related to student learning in mathematics classrooms with a special attention to identities and positioning. Crespo (2016b) provided an example of a pedagogical tool for prospective teachers to engage contraries, foreground the complexities involved in teaching mathematics, and challenge simple labels that might minimize tensions this complex work. With those ideas in mind, I focus on contradictions in mathematics education discourse, more broadly, as framings that shape the ways teachers might reflect upon and engage in practice.

Method

This study was a multidimensional research site wherein data were generated both in monthly meetings and across site visits of a working group of five prospective K-8 teachers over a seven-month period. I organized this voluntary group, and our activities were not associated with required coursework in their teacher preparation program. We focused on developing our mathematics teacher noticing across multiple contexts, including video and in-person analysis of children, with the following goals:

- Expand the way we notice mathematics and mathematical practices in children's lives
- Appreciate children as mathematical beings who engage with mathematical ideas outside of mathematics classroom spaces

- Reflect on narratives about mathematics in connection to identity, teaching, and learning

During our seven working group meetings, we discussed research-based mathematics education readings, participated in activities related to our teacher noticing work, and engaged in reflections on our own learning. The conversations in this paper took place during our last working group meeting where we reflected on our activities and learning across the year.

Participants

I introduce the prospective teachers in this study with information about their school mathematics experiences as a window into their stories. I draw on excerpts from our first writing activity, a mathematics autobiography (Aguirre, Mayfield-Ingram, & Martin, 2013), where each prospective teacher described previous experiences with mathematics in school and how these experiences shaped who they wanted to be as a teacher. Four prospective teachers participated in an idea mapping activity during our last group meeting: Liv, an Asian woman who is an international student from Indonesia; and Ann, Beth, and Kate, who are White women from different locations in the Midwestern United States. All names are pseudonyms chosen by each prospective teacher.

Liv was pursuing an Elementary Education degree with a focus on language arts and a teaching minor in TESOL. She was in her second year at the university as an international student from Indonesia and entered our working group at age 19. Liv described her experiences with school mathematics as "nothing but frustration and aversion," filled with failing grades and extra help from her teachers, family members, and tutors. Although Liv understood mathematics in class, she received low scores on exams often for errors in calculations. She prepared for a mathematics national exam in sixth grade and earned a score of 76%, which shifted her view of mathematics as a subject that she could do well with some work. In middle school, Liv still did

not see mathematics as an easy subject but "if [she] dedicated time and effort, [she] could succeed." As a future teacher, Liv seeks "to break down all the typical stereotypes about mathematics for [her] students," emphasizing that mathematical skills are not inherent.

Ann was pursuing an Elementary Education degree with a focus on mathematics and a teaching minor in Teaching English to Speakers of Other Languages (TESOL). She was in her second year at the university and entered our working group at age 19. Ann described her experiences with school mathematics as "something that came very naturally to [her]," with mathematics being her best subject throughout middle school and high school. She appreciated her mathematics teachers who supported her learning by explaining concepts in multiple ways. Ann's great experiences with her mathematics teachers were "a big part of the reason why [she wanted] to teach math," and she chose mathematics as her subject area focus in elementary education (K-8) at the university. She briefly doubted this decision, though, while taking calculus as part of her required college coursework, stating, "I felt lost and helpless, and nothing that I did to prepare for the class was being reflected in my grades."

Beth was pursuing an Elementary Education degree with a focus on mathematics. She was in her second year at the university and entered our working group at age 19. Beth was one of my former students in an elementary mathematics content course focused on number and operations in Fall 2014. Beth described experiences with tracking in elementary school where students were placed across three levels; she remembered "always being in the average, middle group, with an occasional change up or down." While she disliked the frequent timed tests in elementary school mathematics, "hard work and good grades fueled [her] into liking math" in middle school. In high school, Beth was placed on an advanced track in mathematics and encountered challenges with calculus—in part because the subject seemed more abstract than

other mathematics and in part because she had four different teachers come and go throughout the year. She noted her love for mathematics as the reason she chose it as her subject area focus in elementary education.

Kate was pursuing an Elementary Education degree with a focus on language arts and teaching minors in mathematics and TESOL. She was in her third year at the university and entered our working group at age 20. Kate was one of my former students in an elementary mathematics content course focused on number and operations in Fall 2013. Kate enjoyed elementary mathematics in school and was placed on an advanced track in middle school. Over her high school years, she gradually lost interest in mathematics as it "became more tedious and challenging." Kate reflected on "how different math courses require more speed, but also patience to overcome challenges," stating, "early mathematics for young children can be as challenging as high school calculus for older students." She hoped to emphasize to her future students the importance of discovery and connections across mathematical ideas, even though there are many rules in mathematics.

Researcher Positionality

I am a Latinx woman pursuing a PhD in mathematics education with a focus on teacher education. At the time of this study, I was in my fourth year in doctoral studies and entered our working group at age 26. My K-12 schooling experiences were in well-funded, predominantly White schools in a large school district in San Antonio, Texas. Throughout my schooling experiences, I participated in numerous outreach programs designed for 'underrepresented minority' students (i.e., women and people of color) in STEM fields. I declared mathematics as my major in college because I bought into the strong messages that I should pursue STEM and that teaching was not a valuable profession for people who were 'good at math.' I ultimately

decided to pursue a PhD in mathematics education because I needed to exit these mathematics spaces where I repeatedly felt marginalized and tokenized.

My perspective on teaching and learning mathematics stems from my experiences with teachers and students who are not served by narrow perspectives on mathematics education. As a person who regularly interacts with teacher educators and university researchers, I have grown tired hearing (and am extremely critical of) comments from colleagues that elementary education students do not have strong mathematical knowledge and generally do not care about teaching mathematics. As a mathematics teacher educator, I have had multiple interactions with prospective elementary teachers that suggest otherwise. I become especially enraged when I encounter commentary about prospective elementary teachers that shames their mathematical deficiencies—a discursive move devaluing (often) young women without recognizing them as people who are already mathematical beings of worth. In this paper, I speak back to deficit framings of prospective elementary teachers.

I take an interpretive stance in my work with commitments to equity and justice in mathematics education. My interpretations are shaped by my lived experiences as a Latinx woman who successfully navigated schooling structures and traditional mathematics classroom spaces. Additionally, my interpretations are continually shaped by my experiences as a mathematics teacher educator and researcher who navigates predominantly white institutions. As a teacher educator, I serve as an advocate for teachers, their learning, and most importantly, their students' learning. I encourage teachers to challenge assumptions, embrace complexities, learn from students, and strive to make mathematics classrooms more humane through their professional work (Aguirre et al., 2013). While my work is inspired by participatory action research—working collaboratively alongside the women in this study—I took up a leading role

as facilitator and was often positioned as a teacher educator in this space. Nonetheless, as a mathematics teacher educator, I view my work as practitioner inquiry.

Data Generation

I chose to pursue ethnographic traditions in this work because my active participation in the working group allowed me to get close to the prospective teachers across the multiple contexts we navigated. In this framing, I drew on ethnographic participation that allows "access to the fluidity of others' lives and enhances sensitivity to interaction and process" (Emerson, Fretz, & Shaw, 2011, p. 3) in my exploration. Although my study is not an ethnography in the classic sense, the methodological tools of ethnography, such as participant observation and field notes, allowed me to capture the social complexity of our working group conversations.

During our 90-minute working group meetings throughout the year, we discussed research-based mathematics education readings, participated in activities related to our teacher noticing work, and engaged in reflections on our own learning. For our final meeting, the overarching theme was reflecting on mathematics teacher noticing as a practice and what the prospective teachers learned from all our activities during our time together during the year. Data were generated through verbal discussion and artifact construction during our last working group meeting activity, an idea mapping task. I had two cameras positioned in the room: one at a wide angle to frame the entire group and one close angle to frame the chart on the table.

Due to the voluntary structure of our working group, we did not have a consistent meeting time and location. Consequently, some of our monthly meetings took place at two different times with smaller groups. For this paper, our last meeting occurred during two consecutive days: Beth and Kate attended a meeting with me (4/13/2016) and the next day Ann

and Liv attended a meeting with me (4/14/2016). Both meetings focused on the same activities with an idea mapping task and reflections.

Idea Mapping Task. Introducing the idea mapping task, I provided each prospective teacher with a marker and pad of sticky notes and explained that we would be constructing a representation of our ideas and learning across the year during our working group activities. While the mapping activity would primarily be discussion-based, I provided sticky notes to keep track of our ideas, especially if someone else was speaking and we did not want to lose our thoughts. I encouraged prospective teachers to write one idea per sticky note to place on a larger blank chart paper in creating a larger idea map. I chose post-it notes as a tool to allow for a more fluid movement of ideas. I also encouraged revisiting ideas by including both written and spoken forms of communicating. Both design features in this activity were intended to support thoughtful engagement with contradictory ideas.

During our construction of the idea map, I suggested sticking related notes near each other and noted that we could move the sticky notes around during the activity (Figure 11). While giving instructions for the task, I specifically prompted the prospective teachers to connect noticing to identity while acknowledging potential contradictions:

> We did our noticing, but we're also connecting to identity and trying to make sense of '*How do they go together? How do they not go together?*' And I've noticed that in our conversations there are some things that seem contradictory to me. We say things, and I'm like, '*those don't seem to go together*,' so this whole process is to try to make sense of what things go together, what things don't, or let's try to dig deeper and think about the things that seem like they don't go together, do they actually go together? [Lynette, Group Meeting, 4/14/2016]

An affordance of using sticky notes was that they could be moved around, which would be a useful tool to place two or more ideas that seemed contradictory adjacent to each other.

After constructing an idea map during the second meeting with Ann and Liv (4/14/2016), we merged our idea map with the map constructed by Beth and Elise the previous day. Figure 12 shows the completed idea map across both groups.

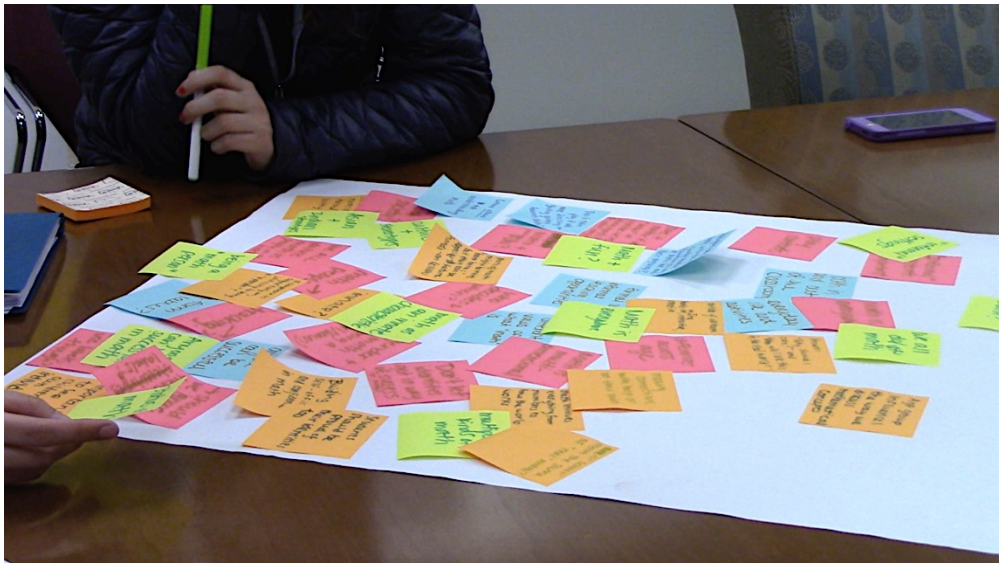

Figure 11. Prospective teachers constructing an idea map representation of their learning.

Figure 12. Completed idea map across two groups.

As a facilitator, my role was to support an in-depth examination of dominant discourses in mathematics education. I also had my own pad of sticky notes and contributed ideas during the mapping activity. Furthermore, I intentionally arranged for different colored pads of sticky notes and markers so that I could have a visual cue of who had contributed to the conversation. That is, if I noticed more sticky notes of one color than the other colors, I could make discursive moves to redistribute conversation time more equitably throughout my facilitation of this activity.

During my participation, I engaged in active listening to attend to the ways prospective teachers were constructing mathematics, mathematics education, and children through their explanations. I created a list of big ideas for my own reference, based on my previous researcher memos and reflections across the year (Appendix G). The primary questions I wanted to emphasize as a facilitator were: (1) What are we (as individuals) taking away, and how are these ideas connected (or not)? and (2) How do we make sense of our *complex and contradictory* ways of knowing? Finally, I made explicit to the prospective teachers that engaging with complexities and contradictions is difficult intellectual work—work for which I do not have definitive answers and further questions that I continue to grapple with myself as an educator.

Data Analysis

My data analysis methods for the larger study drew on case study research (Stake, 2005; Dyson & Genishi, 2005). I engaged ongoing analysis during data generation using researcher reflections as a starting point for identifying and focusing on interactions from our working group meetings. Primary themes of interest included mentions of mathematics identities through recognizable storylines about mathematics and mathematics education (e.g., *Asians are good at math*). For this idea mapping task, I conducted open coding of transcribed data with a focus

identifying themes based on idea clusters created in our co-constructed map. In addition to reading and rereading transcribed working group discussions and interviews, I also watched and listened to video and audio from these meetings during the open coding process as a different mode to identify potential codes.

While viewing the video data during analysis, I noted when a group member (including myself) added a sticky note to the idea map and what was written on the sticky note. I confirmed what I noted from the video data with the physical idea map artifact. I used this video and artifact analysis to name initial codes, such as "being a math person," "role of society," "math is everywhere," and "anyone can be successful with mathematics." Then, in subsequent iterations, I used memoing and axial coding to refine and consolidate codes to generate themes (Creswell, 2013). For this paper, two main themes were "anyone can be successful with mathematics" and "who is a 'math person'?"

During this recurrent and messy process, I drew on Tracy's (2013) perspective on analysis as "playing, thinking, returning, and cycling through the maze enough times, and with enough creative attention, to be able to recognize a significant and interesting path along the way" (p. 224). My sensemaking and argument building involved exemplars and vignettes. I selected exemplars as "significant and multifaceted examples" (Tracy, 2013, p. 207) that I identified through coding, which summarized what I saw going on in the data. I also used vignette as "a focused description of a series of events taken to be representative, typical, or emblematic" (Miles, Huberman, & Saldaña, 2014, p. 182).

During our final interviews, I intentionally asked each prospective teacher what she wanted teachers, teacher educators, and the public to know about what we might learn from our

work together. Their responses guided the framing of this article; I explored the intricacies of connecting mathematics education to identity narratives through an idea mapping activity.

Findings

Our working group structure provided a space for prospective teachers to develop relationships, collaborate among colleagues, and reflect on the ways in which mathematics is entangled with human beings and our world. Through our working group activities, prospective teachers broadened the ways they viewed mathematics, in general, and children's mathematics, in particular (Article 1, pp. 51–76). In this section, I weave excerpts of conversations across the two meetings to provide examples of our discussions that examined two dominant narratives in mathematics education: 'anyone can be successful with mathematics' and 'being a math person'. These two narratives are often put in conflict with each other—equity efforts in mathematics education seek to dismantle notions of 'being a math person' by placing emphasis on 'anyone can be successful with mathematics'. While seemingly in opposition, I suggest these two narratives might harmoniously co-exist in the ways we talk about mathematics and people. What follows are discussions about making sense of these two narratives side by side.

Anyone Can be Successful with Mathematics

During our previous discussions and written reflections, prospective teachers often called on a meritocratic storyline that *If you just work harder you can get ahead in mathematics*, which connected to a narrative that *anyone can be successful with mathematics* with hard work and persistence. This narrative was present in the stories prospective teachers told about their own schooling experiences, such as in the mathematics autobiography excerpts in the previous section. Furthermore, this narrative was supported by another common discourse in mathematics education, *mathematics is everywhere*, as we explored and identified mathematical ideas across

out-of-school contexts. Although taking a perspective that *mathematics is everywhere* might be valuable to broaden what counts as mathematics, I brought forward my critical interpretations of this statement to facilitate conversations to grapple with nuances in accepting multiple kinds of mathematics and connections across multiple disciplines. In other words, I made visible my stance that mathematics is important but not necessarily *more* important than other subjects taught in schools.

From my perspective, a narrative that 'anyone can be successful with mathematics' seemed contradictory with tracking structures in schools that sorted students in hierarchical positions—the more 'advanced' tracks would provide more status and avenues toward 'success' with mathematics. I wanted to explore these ideas in more depth with the prospective teachers, so I posed a question linking 'tracking' and 'success in mathematics,' as shown in Table 2.

Table 2. Complicating Constructions of 'Being a Math Person'

Lynette:	1	Does tracking allow for everyone to be successful in mathematics?
Ann:	2	I think it does because for those who might catch on a little more quickly than
	3	others to math, it gives them a chance to kind of challenge themselves, but at the
	4	same time, for people who might just need a little extra help or might just need to
	5	take a step back and just maybe not go as fast as everybody else, it gives them a
	6	chance to be successful in math. I mean, I don't think the level of math really
	7	matters as long as you're successful in whatever level you're in.
Lynette:	8	So, in particular, I am thinking about like [moves *'Anyone can be successful in*
	9	*math'* next to *'being a "math person"'*] this cluster—I'm going to put it over
	10	here. If we agree that anyone can be successful in math, but we have a lot of
	11	people who say that they're not a math person, how is that possible?
Liv:	12	I guess it's just the culture around here, honestly. …America is a culture that is
	13	really ashamed to say *'I can't read'* but they're proud to say that '*we can't do*
	14	*math*,' so I don't know. I guess it's just there has to be something done about that
	15	view. I don't know. I guess it's just in everyday life. Like when it's 8 a.m. and you
	16	say, *'Oh my god, it's too early to do math!'* because like you're buying coffee in
	17	the morning and you don't want to count the change or something like that. It's

Table 2 (cont'd)

	18	just something that I hear every day, especially because I work in retail[40].
Ann:	19	I feel like it's also a cultural thing because when people—I feel like people
	20	assume that if you struggled with one concept in math, then well you're
	21	automatically not good at it. Or if you really enjoy reading, then you're typically
	22	not a math person, but I think that it doesn't matter if you're as good as someone
	23	else at math, you can still be successful in math without—I don't know how to
	24	word this…

In this excerpt, I placed two sticky notes next to each other, '*anyone can be successful*' and '*being a "math person,"*' as an invitation to explore how these ideas could make sense together (lines 8-11). I intentionally made this move after hearing Ann's response that tracking might afford successes to students "who might catch on a little more quickly than others" (lines 2-3) and students "who might just need a little extra help" (line 4). While Ann hinted at multiple kinds of successes for mathematics students, she also seemed to invoke an inherent mathematical ability that some students have (and others do not), largely based on speed.

One possible interpretation of this conversation involves an interaction between societal narratives and individual convictions, which complicates constructions of 'being a math person' as both collective and individual. Liv pointed to her experiences with a larger shared narrative that proudly accepts mathematics as a difficult subject reserved for a select few and is certainly not pleasant to use during morning hours before coffee (lines 15-17). Near the end of this exchange, though, Ann sought to find words to express her thinking as she considered potentially conflicting expectations from societal and individual constructions of being successful with mathematics.

[40] During this academic year, Liv worked at a university dining shop that sold specialty drinks and convenience items.

In Ann's reflection, she commented on how these constructions often lacked nuance—if someone "struggled with one concept in math" then they are wholly viewed as not good with the subject (lines 20-21). Ann expressed her view that "it doesn't matter if you're as good as someone else at math," subtly critiquing the ways we compare and rank students against each other. This statement, though, co-exists with Ann's initial words that tracking allows all students to be successful with mathematics. That is, success with mathematics does not mean you must be a "math person," *and* tracking provides grouping structures for students to experience success with mathematics around other students who might be more like them. Complicating a construction of 'being a math person' through our conversation offered messy considerations for how our individual convictions as educators might interact with societal structures and narratives.

Who is a "Math Person"?

I posed a similar consideration to Beth and Kate, asking how it was possible that we supported an idea that anyone could be successful with mathematics yet a strong dichotomy for 'being a math person' or not was often present in the ways people identified. Beth responded first, agreeing that someone could be a 'math person' or not. She used an example of herself (as someone who did well with mathematics) and her sister (as someone who did well with language arts), stating,

> There are math people, but like everyone has a little bit of math. But you also have your niche in life. So like, if anyone will be successful and be a math person, they could, but I definitely think there are people who it comes more easily to.

Beth's response seemed to invoke an inherent mathematical ability that came more easily to some people than others. I was interested in exploring these ideas further, especially to make

sense of how "everyone has a little bit of math" but also distinguish specializations in which a 'math person' might be constructed (Table 3).

Table 3. Theorizing Identity, Mathematics, and How "We All Do Everything"

Lynette:	1	So then [picks up '*we ALL do/use math as people in the world*' and moves next
	2	to '*math people*'] how does that make sense then? We all do and use math?
	3	And Kate, you can say what you're writing, too. What you're thinking about.
Kate:	4	I feel like maybe if someone's really competent in math early on or language
	5	arts early on, they kinda just… they identify as that, and they just put
	6	themselves, they see that as their main identity in terms of what they're good at
	7	in school… Like if they go with math, they might take more math classes. They
	8	might advance more in math and the other subjects might get more
	9	overshadowed…and then of course that builds the innate theory, like they're
	10	just good at it from the start so then that's what they're always going to be
	11	good at. But I feel like, like for this [points to '*we ALL do/use math as people*
	12	*in the world*'], we all use it. I mean, we all read the newspaper, you know? Or
	13	like a textbook. So it's kinda like since what we're learning in school is
	14	applicable, like everything is applicable in the real world to certain degrees, but
	15	still yet people cling to this '*Oh, I'm more of a literature person*' or something.
	16	So I don't know if that's contradictory, that people still identify as like one
	17	thing...
Lynette:	18	Yeah, so I noticed that you said 'people'—like individual people do that, so
	19	then I wrote what is the '*role of society*?' 'Cause that goes along with our—
	20	these labels, these stereotypes, these bigger storylines, the narratives. Yes, we
	21	are all individuals, but what is the role of society?
Kate:	22	So like, society enacts social norms and that then kind of relates to stereotypes
	23	and labeling.
Beth:	24	Even like—we're saying labels shouldn't be good or bad, but then it's like
	25	'*math people*' and then it's like but that's an identity and it's like, we all use
	26	math and it's like the concept of we all do everything—we all read, we all use
	27	math, we all do… And it's like the role of society. And it's like, our role in
	28	society is gonna be to be teachers and other people have the role of being
	29	doctors so that's their specific thing and that's their identity, but then, we all do
	30	everything, in a way. So like, if a kid gets a cut, I'll be the doctor, put a Band-
	31	Aid on it, but also be like a teacher. So that's like us—everyone doing
	32	everything but also having our identity, which we shouldn't let define us.

Table 3 (cont'd)

	33	[laughs] This is what you're saying about how everything is contradictory, but
	34	it like all connects.
Kate:	35	Yeah, it's like even if a person is a math person, they still might have an
	36	interest in history or reading or some—whatever medium it is, and like vice
	37	versa. Someone might see themselves as a literature person, but they still might
	38	observe math in the real world or participate in stuff like that, so it's like we
	39	identify as something and yet we do all of these things that include other
	40	subject areas, too.

I intentionally asked Kate to share her thoughts first (line 3) because she had not spoken in a few turns and I noticed that she wrote on her sticky note pad while Beth was speaking in the previous turn. She pointed to how these subject-area labels with which we identify (e.g., math person) might be connected to our schooling experiences at young ages (lines 4-7), which is what she wrote down on her sticky note ('*if competent in subject early on, just cling to being a "x person"?*'). Kate continued to speak about a compounded effect where students who identify with mathematics might take more mathematics classes in school over other subjects (lines 7-9), which she connected as part of ideas of mathematical ability as innate (lines 9-11). Closing her thoughts, Kate offered a critique that all people do mathematics, reading, and other skills learned in school, wondering whether ideas of being a 'math person' or 'literature person' were actually quite contradictory.

To build on this discussion, I brought up the role of society in potentially constructing or contributing to these labels (lines 18-21). Kate pointed to social norms as related to stereotyping (lines 22-23). In response, Beth traced connections across the idea clusters in our map. First, she revisited an earlier part of our discussion where we grappled with determining whether labels were "good or bad" and put that next to 'math person' as an identity label (lines 24-25). Then, she brought in our current discussion where we agreed that all people use mathematics and

perhaps, more broadly, that "we all do everything" (lines 25-27). Next, Beth commented on my question of the role of society by speaking about professions. She stated that her role in society would be as a professional educator, in contrast to another person whose professional role is to be a doctor, but then brought this idea back to "we all do everything" (lines 27-30). Beth provided an example of attending to a child who gets a cut (lines 30-31) to illustrate how she made sense of "everyone doing everything but also having our identity" (lines 31-32). Finally, she linked back to the beginning idea of identity (and labels), not letting them define us in limiting ways, and laughed at coming full circle through retracing our ideas while teasing out contradictions (lines 32-34).

In this excerpt, Beth and Kate engaged with contradictions in connecting two ideas, 'we all do/use math' and 'math people,' both of which co-existed in our previous discussions. Kate highlighted contradictions in how people might ascribe more narrow labels onto themselves, even though we are much more complex. Beth also picked up on contradictions across the multiple clusters of ideas we discussed. Ultimately, both women participated in processes of theorizing identity and mathematics, and reached a conclusion that "we all do everything" as multidimensional human beings. I viewed this brief exchange as one of the highlights from this activity—prospective teachers as philosophers and producers of knowledge as they grappled with complex and contradictory ideas.

Similarly, Ann and Liv had interesting discussions about constructions of who is a 'math person'. When I asked if they thought that 'we all do mathematics,' Ann agreed. She used an example from an article we read by Dominguez (2016) about problem posing, arguing that children—even those who might not necessarily consider themselves 'math people'—came up with mathematical problems. Ann stated that supporting children to see the many ways they

engaged with mathematics across contexts was important for "turning what people define to be 'math people' into everyone." Table 4 shows our continued discussion of these ideas.

Table 4. Dispelling the Myth of a "Math Person"

Liv:	1 2	I guess rather than saying that everyone is a math person, I would rather say that there is no such thing as a math person.
Ann:	3 4 5	Yeah, I agree with that. Or like just because you might struggle with math in the classroom doesn't mean that you're necessarily bad at it because you're using it outside of the classroom as well.
Liv:	6 7	And there's so many kinds of math. We just talk about, like maybe you're not good at trigonometry, but you can be good at something else like logarithm or stuff.

Liv and Ann engaged in discourse analysis to make sense of 'math person' as something that might not even exist (lines 1-2), at least in the sense that people are indeed much more complex. Liv's reframing of 'math person' as a myth provided a space to critique mathematics education discourse, particularly ones that position 'math person' as a valuable goal we might want for our students. Instead, 'math person' is dismissed as overly simplistic because people might use mathematics outside classrooms even if they struggle with mathematics inside classrooms (lines 3-5). Related, mathematics involves a plurality of topics and characterizing mathematics as a singular object paints unfair characterizations of ways people can successfully engage with mathematical ideas (lines 6-7).

Discussion

I reflected on my practice as a mathematics teacher educator and what I learned from facilitating an idea mapping activity with a working group of prospective teachers. I argued that engaging with contradictions in this exercise provided prospective teachers opportunities to tease out nuances for articulating differences and reconstruct ideas that generate new perspectives for teaching and learning mathematics. Specifically, I provided examples of our discussions that

examined two dominant narratives in mathematics education: ‘anyone can be successful with mathematics’ and ‘being a math person’.

In this work, I take a stance that contradictions are not necessarily bad. While there might be a desire to resolve contradictions to avoid fallacies in logical reasoning, I propose engaging with contradictions as generative experiences in teacher education. Aligning with work of other scholars (e.g., Crespo, 2016b; Hogan, 2008; Wood, 2013), I offer a contribution to mathematics teacher education that examining our own words provides prospective teachers opportunities to interrogate dominant narratives in mathematics education discourse. By foregrounding contradictions, both by prospective teachers and by mathematics teacher educators, I offer an alternative storyline that mathematics teacher education research could invoke about prospective elementary teachers and topics related to privilege and oppression. Rather than solely framing prospective teachers as unwilling or unable to engage these issues, I suggest foregrounding the complexity and messiness of their thoughts and experiences by engaging with contradictions in broader mathematics education discourse.

During this idea mapping activity, a primary focus was to put two ideas together to consider ways the ideas were complementary and contradictory. Emphasizing that contradictions could be useful, prospective teachers had opportunities to tease out nuances and reconstruct ideas that generated new perspectives for teaching and learning mathematics. Additionally, prospective teachers were philosophers who theorized about identity and mathematics as they made sense of what it is we do as human beings in the world: “we all do everything.” Through this work, prospective teachers attended to identity and power to consider how we might read ‘math is everywhere’ (among other dominant narratives) in our own discourses about mathematics and

mathematics education. Interrogating dominant narratives, prospective teachers also considered ways we might be producing, reinforcing, and challenging messages about mathematics.

I want to note that one aspect of this research design involved prospective teachers revisiting and analyzing their own words (drawing on Marx, 2006) to tease out nuances in our discourse as part of regular working group activities. During individual interviews and selected group meetings, I shared sections of raw transcripts and my analyses with the prospective teachers as "member checks" (Lincoln & Guba, 1985) for feedback on my interpretations and representations of their meaning making. This is an important detail to situate the conversations I shared in this paper because we had already been revisiting our own words and ideas throughout our time together—not from a place of shame but rather as an invitation to explore our own complex thinking.

While the idea mapping activity I share in this paper involves a small group of prospective teachers with a single mathematics teacher educator facilitator, it is possible to consider adaptations for larger group classroom-level engagement. For example, mathematics teacher educators could use Padlet in their classrooms as a virtual and accessible live-editing mapping tool that might better serve larger group contexts. Regardless of group structures and technologies, I suggest considering ways to set up the activity that attends to flexibility and continual reengagement. In my small groups, I used post-it notes to allow for a more fluid movement of ideas. I also encouraged revisiting ideas by including both written and spoken forms of communicating. Both design features in this activity were intended to support thoughtful engagement with contradictory ideas.

Finally, I close with considerations for other lenses and discourses to explore in mathematics teacher education with a framing of complex and contradictory conversations. One

dominant discourse that I might have made more visible during our discussions is how *growth mindset* (Dweck, 2010) has been taken up in (mathematics) education. My concern about growth mindset stems from how it can be used as an accomplice to uphold a myth of meritocracy by placing the burden of educational inequities on individual students rather than systemic marginalization. While growth mindset is often connected to equity efforts, I point to this specific example because I have concern for how people might use them to maintain 'business as usual' to perpetuate inequities that disproportionately marginalize students who are not served by dominant practices in mathematics education. I look forward to more complex and contradictory conversations with prospective teachers to make sense of these connected discourses in mathematics education.

CHAPTER SIX:

BLURRING BOUNDARIES:
WHAT WOULD IT TAKE TO DECOLONIZE MATHEMATICS EDUCATION?

You may say that I'm a dreamer / but I'm not the only one

--John Lennon (1971), "Imagine"

We used to play pretend, give each other different names
We would build a rocket ship and then we'd fly it far away
Used to dream of outer space but now they're laughing at our face
Saying, "Wake up, you need to make money"
Yeah

--Twenty One Pilots (2015), "Stressed Out"

A primary thread across this work involves blurring boundaries within mathematics education. In my first article (pp. 51–76), I provide an overview of boundary blurring that prospective teachers in this study engaged—between mathematics and people as well as between mathematics and other disciplines—through early field experiences in out-of-school contexts. I zoomed in to examine a specific boundary, women and mathematics, in my second article (pp. 83–105) and explored intersections of gender, age, and elementary mathematics during an interaction at a science museum site visit. Then, in my third article (pp. 110–133), I zoomed out to focus on broader discourses within mathematics education to challenge overly simplistic all-or-nothing type stories about mathematics and people (e.g., 'being a math person'). Across my three articles, I explored an overarching question: What stories do prospective teachers tell about themselves, about children, and about mathematics? This study contributes to a collection of stories about prospective teachers' learning to notice children and their mathematical practices with implications for supporting mathematics teacher education, particularly in contexts outside of school.

With much thought, I intentionally chose to use the word *boundaries* rather than *borders*. My obsession with thinking about borders started with reading Gloria Anzaldúa's

Borderlands/La Frontera (1987). As a Texas native, her book felt like home. I was ignited to think more about borders because of the PME-NA[41] 2016 conference theme—*Sin Fronteras*: Questioning Borders with(in) Mathematics Education—and Sandra Crespo's (2016a) plenary about border crossing in her work. However, the word 'border' carries too much baggage for me. I lived in Arizona for four years and saw *border* patrol everywhere, heard people chanting 'build the wall' as a rallying cry to secure our *borders*, and read through multiple iterations of laws where police could ask to see your papers to ensure you were legally within your *borders* of land. Countries have borders—what if we imagined no countries? Is it hard to do?

'Border' and 'boundary' also strike up different imagery in my mind: a border is solid, opaque, and guarded; a boundary is malleable, a stretchable limit that opens more space. To me, 'border' seems confined to a physical space, a binary that exists or does not. 'Boundary' seems more fluid and creative, not final; a limit that *could* be infinite. Boundaries can be pushed. But boundaries also make me think about colonization, establishing boundaries around claimed areas and people. I view boundary blurring within mathematics education as an action to create possibilities for a less constraining, less violent mathematics education—a project of decolonization, undoing legacies of control, domination, and dehumanization.

A Project of Decolonization

> Everyone wants to be a King or a Queen but no one wants to be a Healer, a Warrior, a Shaman, a Witch, a Messenger, a Farmer, a Builder, a Friend, a Guide, a Family.
>
> White supremacy has convinced us that the true display of power rests in ruling and the desire to control. What if I told you that true power rests in supporting? The ability to cultivate, maintain, and advocate for a nation is an incredible gift—one that is done in corroboration with others. Black healing matters.

[41] North American Chapter of the International Group for the Psychology of Mathematics Education

Decolonize the mind.

Revitalize the body.

Liberate the soul. (Wiley, 2017)

The subtitle of this section is inspired by a conversation facilitated by Dr. Dorinda Carter Andrews in a Critical Race Theory in Education class (Spring 2016). While I am still learning about postcolonial and decolonial work, I began thinking about projects of decolonization from literature in TribalCrit. I read a book chapter by Writer (2012) that hit me with intense emotions. I was overwhelmed with anger as I read about the Sand Creek Massacre. Angry because it happened. Angry because I do not remember learning these stories through my schooling. Angry because these stories are largely not part of anyone's schooling in the United States, stories of slaughter intended to leave 'no child left behind.' This word choice intentionally linked colonial atrocities to educational policy. When I was younger, my dad used to always tell me, "History is written by the victors." I say no; history is written by the colonizers.

Colonizers manufactured stories of patriotism and bravery that erased the stories, lives, and oppression of entire groups of people. This also fuels my anger. What sometimes gets lost in arguments about our white middle-class standardized curriculum is that this issue is much larger than a desire to have brown and black people represented and visible: Stop lying and miseducating children to be pawns in upholding white supremacist colonialism. Through these reflections, I felt for the first time that I understood a bigger picture much grander than my lived experiences as an individual or as a member of a racial group. Colonization deeply infects us all. Writer (2012) articulated the oppression that forcefully infects schooling in the United States: "This curriculum is concerned with the agenda of inculcating patriotism and developing an obedience of not questioning information, limiting one's exposure to diverse histories, multiple perspectives, and experiences of marginalized and colonized peoples" (p. 15).

As I continue my journey as a scholar, I embark on a life project of decolonization—decolonizing my mind, body, and spirit through seeking liberation. Colonial discourse is present in our language about schooling in ways that are visible and invisible. For example, the Committee of Fifteen on Elementary Education wrote the following text in a report:

> The educational value of arithmetic is thus indicated both as concerns its psychological side and its objective practical uses in correlating man with the world of nature. In this latter respect as furnishing the key to the outer world in so far as the objects of the latter are a matter of direct enumeration, capable of being counted, it is the first great step in the conquest of nature. It is the first tool of thought that man invents in the work of emancipating himself from 143hralldom to external forces. For by the command of number he learns to divide and conquer. (National Education Association, 1895, p. 52)

Arithmetic as a subject of value to schooling is partially motivated (in this report) by its utility "in correlating man with the world of nature." More directly linked to colonial discourse, counting is suggested as "the first great step in the conquest of nature," establishing dominance and control over it. *Mastering* arithmetic, then, is one way to learn to "divide and conquer" nature (and perhaps more sinisterly, other people) in the world.

I have given much thought to the violence of control, especially in schooling and our perspectives on teaching and learning. As Simmons (2015) articulated in discussing how students of color confront imposter syndrome, "There is emotional damage done when young people can't be themselves, when they are forced to edit who they are in order to be acceptable. It's a kind of violence." I view this violence as an effect of hidden colonization that continues to be justified. As Mohanty (2003) wrote, "However sophisticated or problematical its use as an explanatory construct, colonization almost invariably implies a relation of structural domination and a suppression—often violent—of the heterogeneity of the subject(s) in question (p. 18). Taking on these perspectives, why might mathematics education researchers and teachers want

to control students' learning (e.g., learning progressions, learning standards, and standardized assessments)? What ethical considerations are overlooked through these endeavors?

While I would like to embark a project of decolonizing mathematics education, I am not sure I am currently at a place where I can imagine it. I struggle with my undying pessimism due to the far-reaching and deeply-seated existence and impact of colonialism. Can mathematics education be decolonized? Has anything been decolonized or, like similar work against systems of oppression, is it always a continual process of decolonization? Perhaps we are already working on decolonization projects and cannot tell because it is too soon to see our impacts? I do not have definitive answers to these questions.

My optimistic, action-oriented desires center a need for generations of people to engage a transformational movement for (mathematics) education. We might not be able to fully dismantle interlocking systems of oppression during our lifetimes; however, silence does not seem to be a justifiable option. The ways we construct 'mathematics' and 'mathematician' must be fundamentally grounded in humanity. Perhaps my call, then, is to dismantle a hierarchy of mathematics over humans and living beings—mathematics (and mathematics education) as efforts that do not seek to conquer or tame. Although I hardly consider myself an idealist, I maintain a critical hope as I am encouraged by coalition building within and outside of mathematics education for more humanizing engagement in schools and communities. At the same time, though, there are many complexities, messiness, and struggles in moving through this praxis work.

Blurring (and Pushing) Boundaries

> My role—and that is too emphatic a word—is to show people that they are much freer than they feel, that people accept as truth, as evidence, some themes which have been built up at a certain moment during history, and that this so-called evidence can be

> criticized and destroyed. To change something in the minds of people—that's the role of an intellectual. (Foucault, 1988, p. 10)

One of the prospective teachers in this study, Beth, said during a group meeting that with school mathematics, "you're either right or you're wrong, and there's not really much in between" [Group Meeting, 1/29/2015]. These words pose a challenge to mathematics education: What might our work as mathematics (teacher) educators look like living in the borderlands of right/wrong? This is where my equity work lies. I seek to blur (and push) boundaries in my continued scholarship, continually attending to disrupting the ways I might be complicit in upholding boundaries within mathematics education. Complicity can be uncomfortable to acknowledge; however, it is important to constantly think about because of agentive possibilities—ultimately, we can choose to act and think differently. Foucault's words currently sustain my hope, resistance, and self-reflection: *we are freer than we feel.*

My broader project requires commitments to both educators and students in mathematics teacher education. That involves designing and engaging experiences in teacher education for prospective and practicing teachers to see themselves as educators who have mathematical worth, and to see children as students who have mathematical worth. It also requires careful reflection on my practice as a teacher educator: Do *I* see prospective and practicing teachers as people of mathematical worth in humanizing framings? Am I actively questioning my own thinking and assumptions about what mathematics education is and should be (if at all)? Finally, it requires that I attend to ethical considerations as a researcher: Who benefits from this work? How am I framing other people's (our) stories with dignity and love? In closing, I share three questions of inquiry that I hope to pursue during my next steps in this journey.

How do teachers engage this type of noticing work in practice?

I was not able to follow the prospective teachers in this dissertation study, but I would have loved to work with them through the rest of their preparation program and during their first few years of teaching. One major challenge for teacher education involves conflicts between theory foregrounded in courses and complexities of practice in classrooms (e.g., Leatham & Peterson, 2010). Accountability pressures from state standards, teacher evaluations, and standardized testing contribute to a disconnect between course activities in teacher preparation programs and dominant teaching practices in school placements (e.g., Crespo, 2016c). These pressures also have contributed to complex tensions teachers face when considering and engaging equity-based practices in their classrooms, such as teaching mathematics for social justice (see Wamsted, 2012).

Because of the complexities of teaching contexts, I would like to better understand how teachers might negotiate noticing work during their professional work by following prospective teachers into their first years of teaching. I also am curious about developing a professional development structure (perhaps modeling professional learning communities) for practicing teachers to explore noticing children's mathematical practices in out-of-school contexts. While these contexts for teacher education pique my interests, I must admit that I have hesitations for imagining this professional work at larger scales. Specifically, I wonder whether there might be (or should be) limits to what contexts and situations are mathematized. Are there dangers of dehumanization through these efforts, and if so, who decides what is off limits?

What boundary blurring work might be engaged in STEM outreach spaces?

A second primary strand of work I hope to pursue involves STEM outreach spaces. I would like to use critical race theories to examine gendered and racialized narratives within

STEM outreach programs that target representation of women and people of color. I am motivated to explore these outreach programs as I continue to interrogate my own past experiences with these programs, both as a student and as an educator. I constantly grapple with a seeming incompatibility between my desire to support historically marginalized students in mathematics and my cautiously critical orientations toward mathematics outreach that pushed me into marginalizing mathematics spaces and away from a more holistic view of myself. Connecting to the tenet of interest convergence, I wonder how mathematics outreach programs maintain white supremacist patriarchal forms of oppression. Drawing on Gillborn (2016), I pose the following questions in my continued interrogation: (1) Who or what is driving STEM outreach? (2) Who wins and who loses in this push for increasing the number of "underrepresented minorities" in STEM-based careers? And (3) What are the outcomes/effects of these STEM outreach programs?

Inspired by Evans-Winters and Esposito's (2010) call for female scholars of color "to directly confront, unabashedly, the social and educational needs of minority girls of color" (p. 12), I am quite critical of whether mathematics outreach programs successfully support girls of color as they try to survive in these spaces that are not built for them to thrive. An increase in programs and numbers that suggest we are improved; however, my (and others') story(ies) does not serve as supporting evidence. The strong tensions I deal with as a mathematics educator involve my resistance to uphold oppressive systems that want Latinxs to assimilate in order to prove our worthiness in mathematics and my ongoing support for Latinxs in our fight for liberation to be the human beings we want to be in the world. My intention in this questioning is not to bite the hand that fed me, but rather to speak to my lived experiences as a 'product' of these programs, so I feel aptly positioned in my critique. What boundaries might be blurred

within these STEM outreach spaces? What could we learn from these spaces for K-12 mathematics classrooms?

How might teacher education sustain prospective (and practicing) teachers of color?

Much recent attention in mathematics teacher education research has focused on (mostly) White prospective teachers confronting issues related to privilege and oppression in schools (e.g., Bartell, 2012; Bieda, 2016; Melgar & Battey, 2016; Ullucci & Battey, 2011). Although important work, I am concerned with the ways in which a density that constantly centers issues of Whiteness in teacher education might unintentionally marginalize prospective and practicing teachers of color.

I became increasingly aware of a focus on White preservice teachers during many interviews for academic positions where I was asked to describe my qualifications for teaching in a predominantly white teacher education program or my commitment to 'diverse populations of students.' I often found myself in a conflicting position because some of the first questions that entered my mind were: "But what about prospective teachers of color? How do we sustain *them* in our teacher education spaces?" For one job interview, I asked the committee about the demographics of their teacher education program and was told it was predominantly white, but during my teaching demonstration I could not help but notice that there were multiple prospective teachers of color in the classroom, all sitting together at the same tables. Does an intense focus on White prospective teachers inadvertently make prospective teacher of color invisible in our classrooms?

One example that directly connects to this dissertation study was Liv's experiences as the only prospective teacher of color in our working group. Her own story countered a dominant stereotype that *Asians are good at math*; in her mathematics autobiography, she described herself

as “a walking numerical disaster” and even identified herself as a “literary person” in her interview. During a group conversation about mathematical identity narratives and stereotypes, Liv pointed to feelings of discomfort and stated, “I’m starting to fear that if this is how people in America, I guess, view Asian students… and the moment us Asian students come into your classroom and you think, ‘*Oh, you’re going to need less help from me*’” [Group Meeting, 10/5/2015]. When I asked the White prospective teachers what they thought about Liv’s comment during individual interviews, many of them pointed to this comment as important for their reflections because it was not necessarily a perspective they previously considered. How might mathematics teacher educators attend to and support prospective teachers of color?

Live, Love, Liberation

My hope for readers of this dissertation work was to join me on a journey: navigating stories from my life, stories from a small working group of five prospective K-8 teachers, and stories about philosophical ponderings both within and outside of mathematics education. Although I often consider my presence and engagement in mathematics education research spaces as a form of unapologetic resistance, I also find myself full of doubt that this is a space I should be in. It is one thing to hold strong convictions to embrace unapologetic resistance; however, resistance still takes up energy. And I am exhausted.

While I might grow stronger through these experiences, my muscles still fatigue. Self-care is essential for survival. At some point, though, I hope to move beyond survival and onto thriving. I write all of this with a hopeful criticality: I am freer than I feel. With these five years, I feel more comfortable and more authentic to my own voice, and I attribute that to what I have learned in fighting for what I know is important to many students and teachers who are not served by narrow perspectives on mathematics teaching and learning. This statement is my

explicit departure with colonizing mathematics spaces: *I refuse to assimilate to uphold your colonizing White supremacist patriarchy; sorry, not sorry.*

I end this dissertation with a dedication to Maximillian Monroy-Miller: you have impacted me more than you might know. You have taught me aspects of my meaning in life that I will forever hold dear to my being. I know I am not alone. The fight for justice and equity is never-ending, multi-faceted, and requires solidarity in the process of becoming more human in our shared world. We stumble. We struggle. We fatigue. But ultimately, *liberation is never for ourselves*. We stand upon the shoulders of giants. We empower and humanize ourselves through storytelling. We find solace and strength within our communities: the fuel that lights our fire. Our work is not easy. For all of that and more, I am grateful to share stories—seeking to better understand ourselves as we come to also better understand each other—and to develop relationships to embrace our human connections. And most importantly for me, continuing to embrace my unapologetic resistance.

To honor Max and all those who came before me, I close with words by bell hooks (2000) that inspire me in moving forward on this journey of liberation:

> Martin Luther King offered a visionary insight when he stated: "Our goal is to create a beloved community, and this will require a qualitative change in our souls as well as a quantitative change in our lives." The individuals who are part of that beloved community are already in our lives. We do not need to search for them. We can start where we are. We begin our journey with love, and love will always bring us back to where we started. Making the choice to love can heal our wounded spirits and our body politic. It is the deepest revolution, the turning away from the world as we know it, toward the world we must make if we are to be one with the planet—one healing heart giving and sustaining life. *Love is our hope and our salvation*. (emphasis added, p. 225)

APPENDICES

APPENDIX A:

Mass Email Solicitation to Prospective Participants

Sent: 9/23/2015

Subject: Mathematics Education Research Project Opportunity: Learning to Notice Children's Mathematical Practices

Dear Elementary Education Student,

My name is Lynette Guzman, and I am a doctoral candidate in the Program in Mathematics Education at MSU who is interested in supporting elementary mathematics teacher learning. I would like to invite you to participate in a mathematics education research study I am conducting that focuses on learning to notice children's mathematical practices. You have been selected as a possible participant in this study because you were enrolled in a previous semester of MTH 201 or MTH 202.

I am seeking volunteers to be part of a professional learning community[42] focused on learning to notice children's mathematical practices. Through our community, we will explore possible messages about what it means to recognize mathematics in our (and our children's world) and how teachers learn to notice children's mathematical competencies inside and outside the classroom. I attached a general overview of PLC activities to this message.

An example of what we will be working on in this community includes video-based tasks, such as this YouTube clip of preschoolers at a sensory table: https://youtu.be/fdZJiWnxhg0. We would explore how we notice the children engaging with mathematics and mathematical practice in this video clip and discuss how we can use this knowledge in the classroom as elementary teachers. Additionally, we will visit sites (e.g. science museum) to observe children with a similar focus on noticing their mathematical practices.

No cost will be incurred to you based on your participation in the study. All of the activity materials required for the research will be provided. You will be provided meals at on-campus meetings and Amazon gift cards as compensation for your participation in the study. You will be compensated $10 for each semester (Fall 2015 and Spring 2016) of research activities, and $10 for completing final individual and group interviews. If you participate in every portion of the research, the total compensation will be $30 in Amazon gift cards. Additionally, I intend to do my best to provide support in this space as an opportunity for professional growth as we think about our development as educators.

Attached is a consent form that further explains the details of this study. Participation in this

[42] At the time of my dissertation proposal and participant recruitment, I used the term 'professional learning community' (PLC), which inspired the design of this work. I later changed this language to 'working group' because I felt that it better described our activities.

research project is completely voluntary. Whether you choose to participate or not will have no affect on your grade or evaluation in any related teacher education courses. Additionally, this project does not intend to evaluate your performance or your teacher preparation program.

If you are interested in participating in this study, please review the attached consent form and contact me by email at guzmanly@msu.edu at your earliest convenience. I will host an open house event at Brody (meals paid for by me) to learn more about the project, if I have enough interest in responses – so please let me know if you have any interest in this professional development opportunity! I sincerely appreciate your consideration. Feel free to contact me if you have any questions or concerns.

Best regards,
Lynette Guzman

[ATTACHMENT 1: Overview of PLC Activities]

AREAS OF EMPHASIS IN THE PLC:

- Expand the way we notice mathematics and mathematical practices in children's lives
- Appreciate children as mathematical beings who engage with mathematical ideas outside of mathematics classroom spaces
- Reflect on narratives of mathematics in connection to identity, teaching, & learning
- Other areas of emphasis will be decided upon among the PLC members

PLC ACTIVITIES: GENERAL TIMELINE

This is a very broad overview of how I envision our PLC work; however, the people who are part of the PLC will shape the final decision for how we choose to focus our learning over this year.

PLC DAY	Sem.	Noticing Multiple Mathematical Practices	FOCI
1	Fall	Mathematical Thinking Lens	Introduction to noticing lenses
*	Fall	**SITE VISIT – Mathematical Nature Walk: How do we "see" math in our world?**	
2	Fall	Mathematizing Lens	Highlighting students' mathematical thinking as mathematical practice
*	Fall	**SITE VISIT: Mathematics in a Science Museum**	
3	Fall	Evidence of Children's Multiple Mathematical Practices	
4	Spring	Developing Mathematical "Eyes & Ears": Focusing on children's verbal and written language	Highlighting multimodal interactions as mathematical practice
*	Spring	**SITE VISIT: Classroom context or after school context**	
5	Spring	Developing Mathematical "Eyes & Ears": Focusing on children's body and gesture	
*	Spring	**SITE VISIT: CHOICE**	Noticing in practice
6	Spring	What does this noticing work mean for us as teachers?	

Approximate time commitment: 20-25 hours (over Fall 2015 & Spring 2016 semesters)

[ATTACHMENT 2: Consent Form, See Appendix B]

APPENDIX B:

Research Participant Information and Consent Form

You are being asked to participate in a research study. Researchers are required to provide a consent form to inform you about the research study, to convey that participation is voluntary, to explain risks and benefits of participation, and to empower you to make an informed decision. You should feel free to ask the researchers any questions you may have.

Study Title: Learning to Notice Children's Mathematical Practices
Researcher and Title: Lynette Guzman, Ph.D. Candidate
Department and Institution: Program in Mathematics Education, Michigan State University
Address and Contact Information: 122 North Kedzie Hall, 354 Farm Lane, Michigan State University, East Lansing, MI 48824; guzmanly@msu.edu; 210-454-9112
Project Chair: Dr. Amy Parks, parksamy@msu.edu

You are invited to participate in a research study about teacher learning. The purpose of this study is to better understand how prospective elementary teachers make meaning of their learning to notice students' mathematical practices. You have been selected as a possible participant in this study because you have completed an elementary mathematics for teachers course. You must be at least 18 years old to participate. The estimated time commitment for participation in this study is 25 hours over the 2015-2016 academic year.

In this study you will be asked to participate in a professional learning community focused on learning to notice and connect students' mathematical practices for teaching mathematics. All activities will be coordinated through the professional learning community with accommodations to your availability. The researcher will collect all artifacts from our professional learning community activities. You will not directly benefit from your participation in this study. There are no foreseeable risks associated with participation in this study; however, there is a risk of potential discomfort if you do not agree with the interpretation of data made by the researcher. In addition, you may experience discomfort as a result of knowing that you may be portrayed on videotape in educational environments, such as classrooms and research conferences. The researcher will seek to minimize these potential discomforts by preserving your anonymity in written publications and minimizing attention to individuals in publically shown video clips.

The results of this study may be published or presented at professional meetings and educational settings, but the identities of all research participants will not be shared with others without written permission. Every effort will also be made to protect the confidentiality of the information provided. All materials will be kept in a secure and locked location and only the researcher will have access to the data. Pseudonyms will be used to disguise personal identifiers in any written reports, publications, and presentations.

Participation in this research project is completely voluntary. You have the right to say no. You may change your mind at any time and withdraw. You may choose not to answer specific questions or to stop participating at any time. Whether you choose to participate or not will have

no affect on your grade or evaluation in any related teacher education courses. If you choose to withdraw from the study, the information that can be identified as yours will be kept as part of the study and may continue to be analyzed.

No cost will be incurred to you based on your participation in the study. All of the activity materials required for the research will be provided. You will be provided meals at on-campus meetings and Amazon gift cards as compensation for your participation in the study. You will be compensated $10 for each semester (Fall 2015 and Spring 2016) of research activities, and $10 for completing final individual and group interviews. If you participate in every portion of the research, the total compensation will be $30 in Amazon gift cards.

If you have concerns or questions about this study, such as scientific issues, how to do any part of it, or to report an injury, please contact Lynette Guzman (210-454-9112; guzmanly@msu.edu; 122 North Kedzie Hall, 354 Farm Lane, MSU, East Lansing, MI 48824).

If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or e-mail irb@msu.edu or regular mail at Olds Hall, 408 West Circle Dr Rm 207, East Lansing, MI 48824.

Thank you for your consideration and assistance.

Best regards,

Lynette Guzman
Ph.D. Candidate, Michigan State University
Program in Mathematics Education

Amy Parks, Ph.D.
Associate Professor, Michigan State University
Department of Teacher Education

Research Participant Information and Consent Form

Study Title: Learning to Notice Children's Mathematical Practices
Researcher and Title: Lynette Guzman, Ph.D. Candidate
Department and Institution: Program in Mathematics Education, Michigan State University
Address and Contact Information: 122 North Kedzie Hall, 354 Farm Lane, Michigan State University, East Lansing, MI 48824; guzmanly@msu.edu; 210-454-9112
Project Chair: Dr. Amy Parks, parksamy@msu.edu

Participant's Name (Please Print)

Initial all (items 1-4) that apply:

1. _____ I give permission for data to be used from written transcripts of group discussion, interviews, and artifacts for educational and research purposes.

2. _____ I give permission for my audio/video recordings to be used for educational purposes in classroom settings.

3. _____ I give permission for my audio/video recordings to be used for educational purposes that will appear online.

4. _____ I give permission for my audio/video recordings to be used in professional publications and presentations.

Please check:

____ I CONSENT TO TAKE PART IN THE RESEARCH STUDY.

____ I **DO NOT** CONSENT TO TAKE PART IN THE RESEARCH STUDY.

My signature below indicates that the researcher has answered all of my questions to my satisfaction and that I consent to take part in this study. In addition, I have been given a copy of this form to keep.

_____ _____

Researcher Signature Date Participant Signature Date

APPENDIX C:

Overview of Working Group Activities

Table 5. Overview of Working Group Activities

Date		Description of Activities
10/5/15	M0	*Introduction to project* – initial exploration of our narratives about identity and mathematics
10/19/15 10/22/15	M1	*Introduction to noticing lenses* • Mathematics Autobiography • Parks (2015) chapter: "Exploring Mathematics through Play" • Activity: Noticing mathematics in video – preschoolers at a sensory table
	S1	*SITE VISIT – Mathematical Nature Walk (river trail & children's garden)*
11/5/15	M2	What is professional noticing? • Thomas et al. (2014) article: "Professional Noticing: Developing Responsive Mathematics Teaching" • Defining "mathematics teacher noticing" as a group • Activity: Video observation– *Jayden had 17 flowers. She picked 20 more flowers. How many flowers does Jayden have now?*
11/21/15	S2	*SITE VISIT: Mathematics in a Science Museum*
11/21/15	M3	*Debriefing of our mathematics noticing in practice at science museum* • Focus on both mathematical and non-mathematical activities/practices
1/28/16 1/29/16 2/8/16		*INDIVIDUAL INTERVIEWS: reflecting on our own verbal words and written reflections*
1/29/16	M4	*Debriefing fall semester and moving forward in our noticing work* • Analyzing interaction in science museum: intersections of gender, age, and elementary math
2/17/16 2/24/16	M5	*Building on our understanding of noticing in mathematics classrooms* • Dominguez (2016) article: "Mirrors & Windows into Student Noticing" • Geometric bubbles activity
3/23/16	M6	*Developing mathematical "eyes & ears": Revisiting play and mathematics* • Teacher Identity Activity: discarding index cards with dimensions of our identities • Parks & Blom (2013) article: "Helping Young Children See Math in Play" • Video observation: Noticing mathematics during play time in classroom
	S3	*SITE VISIT: CHOICE* • Area Public Libraries: play area • Observing children during playtime during babysitting • Family math night
4/13/16 4/14/16	M7	*What does this noticing work mean for us as educators?* • Revisiting and rewriting our definition of "mathematics teacher noticing" • Debriefing site visit activities • Making sense of our work: mapping our important ideas and takeaways
4/29/16 5/3/16 5/6/16 5/11/16 8/9/16		*INDIVIDUAL INTERVIEWS: reflecting on our own verbal words and written reflections*

APPENDIX D:

Participants at Each Meeting

Table 6. Participants at Each Meeting

Date		**Brief Description**	**Participants**
10/5/15	M0	*Introduction to project*	ANN, BETH, KATE, LIV
10/19/15	M1	*Introduction to noticing lenses*	BETH, ELISE, KATE
10/22/15			ANN, LIV
	S1	*SITE VISIT – Mathematical Nature Walk: How do we "see" math in our world?*	BETH, ELISE, KATE
			ANN, LIV
11/5/15	M2	What is professional noticing?	ANN, ELISE, KATE, LIV
11/21/15	S2	*SITE VISIT: Mathematics in a Science Museum*	BETH, KATE, LIV
12/6/15			ANN
12/11/15			ELISE
11/21/15	M3	*Debriefing of our mathematics noticing in practice at science museum*	BETH, KATE, LIV
1/28/16	I1	*INDIVIDUAL INTERVIEWS: reflecting on our own verbal words and written reflections*	ANN
1/29/16			BETH; KATE; LIV
2/8/16			ELISE
1/29/16	M4	*Debriefing fall semester and moving forward in our noticing work*	ANN, BETH, KATE, LIV
2/17/16	M5	*Building on our understanding of noticing in mathematics classrooms*	ELISE, LIV
2/24/16			ANN, BETH, KATE
3/23/16	M6	*Developing mathematical "eyes & ears": Revisiting play and mathematics*	ANN, BETH, ELISE, KATE, LIV
	S3	*SITE VISIT: CHOICE*	
4/13/16	M7	*What does this noticing work mean for us as educators?*	BETH, KATE
4/14/16			ANN, LIV
4/29/16	I2	*INDIVIDUAL INTERVIEWS: reflecting on our own verbal words and written reflections*	LIV
5/3/16			ANN
5/6/16			BETH
5/11/16			KATE
8/9/16			ELISE

APPENDIX E:

Interview 1 Protocol

Probing Questions:
Where does that idea/thought/perspective come from?
Can you give an example of a time when…?
Can you say more about who these people are [draw attention to identities]?

PART 1: About Me / Mathematics Autobiography

- *Why did you join this working group?*
  - *Would you recommend a teacher noticing PLC to other future teachers?*
  - *Would you suggest any improvements or changes for this semester work?*
- *How has your teacher noticing shaped the way you think about mathematics? Mathematics education?*
- *[Specific questions about mathematics autobiography]*
  - *Who were your teachers? What were your interactions like? How did you feel in these mathematics spaces?*
  - *How does this experience shape the way you think about math teaching?*
  - *How do you think your thinking about math has changed?*

PART 2: Individual Written Reflections [example: Beth]
Prompt: Is there a moment(s) last semester that stand out as really important to your development of mathematics teacher noticing?
A moment that stood out to me was the trip to the [science] museum. This was an eye opening experience because it made me see math in ways that I didn't know of before. It also made me see how math is even in science and history and many different types of things. It was awesome to see the resources, games, and activities that children have to learn but also have fun at the same time.

PART 3: Transcript Analysis / Revisiting Our Own Words

INITIAL MEETING – 10/5/2015	
	LYNETTE: …for any of these that you wrote down, do you think the narratives are true or false? What do you think about these narratives existing in the world?
1a	**LIV**: most of these are not true… and I feel like you should highlight this: Asians are *not* inherently good at math! [personal experience?] Not me really. It's my neighbor. He goes to high school here – he's from China, though. I interviewed him for my TE class about his HS experiences. The very first thing that he said is that "being the only Asian in class…" and I was like, "Woah, woah, woah. Why did you start like that?" and he's like, "well, it's a physics class and I'm the only Asian in class so everyone comes to me for the answers."
	LYNETTE: It sounds a little bit like some of these things have true aspects to them but for things that you just completely disagree with as not being true, where do those come from? Why do those exist in the first place?

2	**BETH**: Those are like society… it's a society thing, I feel like... like the Asians are good at math, boys are better than girls. It's just like what society has [formed?]
	LILLI[43]: …like it maybe have happened 5 times
	BETH: yeah, and then it gets generalized.
	LILLI: …I think it's something they use to blame, like "oh, well you're better than me because you're a boy" or "you're Asian, that's why".
	LIV: It might also have some historical root to it. I don't know how to put it into words. But some people say that, "oh, if you're good at math then you're going to have a better success later in life" that's probably because 40-50 years ago if you're someone in a STEM area then you're going to make lots and lots of money but that's not necessarily true today.
3	**KATE**: I feel like there's more initiative today to get more girls involved in engineering, math, and science like with the whole STEM initiative. But it's just, even with that though, you'll see people making those generalizations that only boys can do this or you're making fun of girls for how they do—so it still exists, but it seems like there are—like there's campaigns to try to get more females into this profession and everything.
	LYNETTE: Why do you think I had all of us do this [write down narratives about identity and mathematics] in the first place? Why does this matter for what we're trying to do in our learning as teachers?
	BETH: I think it's a way to introduce the whole thing and to also make us cautious of things, so like not stereotype and notice does this student like their professor or teacher – do the students take a liking to them…
	LILLI: I think it's also for us to be aware that it's not—if someone, let's say a student, is struggling in math, there's so many factors that it's, you know, you can't just assume that they don't know the material. I mean, they could have a mental block that's like, "I'm a girl so I'm not going to be as good"…
1b	**LIV**: And on the opposite, I guess… I'm starting to fear that if this is how people in America, I guess, view Asian students and the moment us Asian students come into your classroom and you think like, "oh, you're going to need less help from me".

PLC MEETING #2 – 11/5/2015	
	LYNETTE: How might we use what we notice?
	LIV: Well, at the elementary school I did service learning at they have a gardening club. I think they also do cooking, so after they got their plants, their fruits, and then they cook something and making cakes you certainly need to count and I don't know, I guess they learned a lot of stuff from there. And I don't know if you guys know this, but flowers of the same species, they always have a certain number of petals. So if they're always odd then they're this kind of species, if they're always even they're that kind of species. So yeah that's pretty cool.
4a	**ELISE**: I think in general, it was just really eye-opening to see there was math in so many

[43] Lilli attended the informational meeting (10/5/2015) and initially consented to participate but later withdrew from the study.

	different things 'cause I've never thought about this before. I would never consider a kid playing on the playground to be math-related at all. If I went there just casually I would say, "Oh, they're just having fun." But there's so many different things that are math-related and I feel like that's very useful as a future teacher. You're most likely going to have some sort of playground so you can use that. If it's a middle school, you can definitely, I'm sure, plant a garden in the back or something. You can do something with sports. I know in my middle school there was a football field right behind us so maybe measurements or like related to sports so it's just very interesting. I would never have thought anything really could be math-related… not everything, but…
4b	**KATE**: It really shows how universal it is, and I remember when doing this we would see something and were like, "Oh, that's like math!" We saw the picnic table and were like, "Oh, that's an octagon." It was kind of cool when we had that focus. It really *is* everywhere—and that's really interesting about the flower petals. I didn't know, and that just shows that even nature has a set way of doing things. And that's an interesting fact that a student would like… so I think it just shows how universal math is and it's definitely applicable to a lot of things in nature.
	LIV: Well that got me thinking… it's not… I don't think that kids today know it as kids my age. Like, nowadays we have Nintendo and Xbox and all those stuff so they just sit and stare at the screen, but when I was little we would always go out and sometimes don't have money to buy expensive toys so we made our own toys. Something very popular in my country is kites so—boys especially; I don't do that because I'm not a boy—they would build a kite. They have to measure everything. It has to exactly be that size or else it won't fly. And then you have to measure the wind speed and everything. It's just cool stuff. [inaudible] You can bring it as a class project, but I don't know if they're going to enjoy it.
5	**ELISE**: You've got to find ways to make it applicable to students. That also is just the basis of it. They're going to enjoy it more if it's applicable. I feel like that's the thing that math kind of falters in is teachers think it's just a set thing that you just follow a textbook but there's so many ways to adapt a curriculum and content to be relatable to the kids in math. I don't know. That's what I learn a lot about in class

CLOSING: Part of what I see as important in mathematics teacher noticing is how our identities interact with what teachers notice about children and their mathematical abilities.

- *What are your thoughts about how racial and gender identities could matter for teacher noticing?*
- *Have you had a racialized or gendered experience in mathematics or mathematics education?*
- *Why is mathematics education important to you (and also to your future students)?*
- *Why is mathematics teacher noticing important to you (and also to your future students)?*

APPENDIX F:

Interview 2 Protocol Example (Ann)

Traditional interviews – there is a strict distinction between interviewer and interviewee; however, I would like to invite you to help me blur those boundaries. If at any point you want to ask me a question or what I think about something, please do so. I might answer and then ask you what you think about what I said, and through that process, it is absolutely okay to disagree or to agree with some nuanced differences or to add on with a related idea. I am making a point to say this because I want to be clear that I am not an expert on all things mathematics education. And although I am pursuing a PhD, being a doctoral candidate does not mean that I know it all, and it certainly does not mean I know better. I hope that you feel comfortable and confident in claiming expertise on your own lived experiences and ways of knowing the world. (I will certainly ask you to tell me stories during this interview) With all of that said, I hope to have a good conversation with thoughtful and complex ideas. *Do you have any comments or questions before we begin?*

ABOUT ME (10 minutes)
**What about any other of your identity "cards"

Ann is a White female student pursuing an Elementary Education degree with a focus on mathematics and a teaching minor in Teaching English to Speakers of Other Languages (TESOL). She is in her second year at the university and entered our PLC group at age 19. Ann described the K-5 school she attended as "very diverse" and known for its English language learning program. For grades 6-12, she moved to a suburban city near Detroit, Michigan, which is where she identifies her hometown, and described those schools as "not very diverse". All schools in her K-12 experiences were large and well resourced. Although Ann does not currently have a school placement, she does have previous experiences with children through babysitting, working at a children's summer camp, and tutoring in elementary schools. I am not surprised that Ann is focusing on elementary mathematics in her degree program because she described her experiences with school mathematics as "easy, organized, fun, [and] clear". In joining the PLC, Ann initially noted that the most important issue for mathematics education is "making sure all students understand the material well and can connect it to other topics in math and have a solid math foundation." She alluded that this issue is relevant to her future teaching practices being "clear and organized".

- Do you consider yourself a "math person"?

PLC GROUP (10 minutes)

A moment that stood out to me last semester was going to the [science museum] to observe. This was an important moment to my teacher noticing because it was the first time that I was able to put my noticing into practice in a real time situation. Watching the kids at the water table was really interesting to see and be able to practice my noticing. Also at [science museum], running into the worker was great for my noticing. Seeing him act the way he did because he was a man who was older than me showed me that the narratives that we talk about really come into

play in everyday life. This was important to me because I had never really noticed being treated a certain way because I am a woman and only an undergraduate, and I was able to reflect on how I felt when I was looked down upon by him. This helped me to think of how to avoid treating my students this way, so that they never feel that they are below me or less than me.

- *Would you recommend a teacher noticing PLC to other future teachers?*
- *Would you suggest any improvements or changes (for this semester work or year)?*
- What worked well for you in this experience? Not so well?
- How did you feel about our relationships among members of the group (for your learning)?
- How has this PLC experience gone together (or not) with your other course and field experiences?

(MATHEMATICS) TEACHER NOTICING (15 minutes)

The children that I observed were three girls that I babysit for. One is in the first grade, one in the fourth grade, and one in the fifth grade. I observed them playing with Legos together at their home.

Something that surprised me was how much math I noticed while observing them. I noticed how there was a lot of references to area and perimeter while they were putting together Legos on a certain sized board. They talked a lot about how many Lego pieces it would take them to make a border around the Lego board. Also, they compared sizes of the boards when one girl got angry that hers was smaller. Some other math that I observed while the girls were playing was that they divided up Lego pieces to make sure that each one of them had the same amount. When I mentioned that they were dividing them into thirds, the fifth grader looked at me and said, "Oh, I guess you are right!". The girls also engaged in math when they were trying to make two objects the same size or length. They had to add and subtract Lego pieces in order to make them the same size, and measure and compare them as they added and took away pieces.

While observing this, I was thinking about how I could use what I noticed if I were in a classroom setting. I was thinking about using these instances as examples when working out problems in class. Also, I was thinking about what to say to the girls when I notice these things, or if I should say anything at all. Since I have a close relationship with them, I felt comfortable making mathematical comments about what they were doing. If I were observing children that were strangers to me then I would not feel comfortable making comments to them.

An identity narrative that I noticed when observing the girls is that they played games with the Legos such as "house" and "store", as opposed to building spaceships and vehicles. Also, the Lego kits that they used were pink and purple, and were geared more for girls. What this means for me as a mathematics teacher is that I am going to be careful to not enforce these narratives in a way that would make someone feel uncomfortable if they do not fit "their narrative". Being aware of these narratives also helps me to see how a child may feel out of place or like they don't belong if they do not fit the narrative.

- Noticing definition (co-constructed) – are there things that math teacher noticing misses?

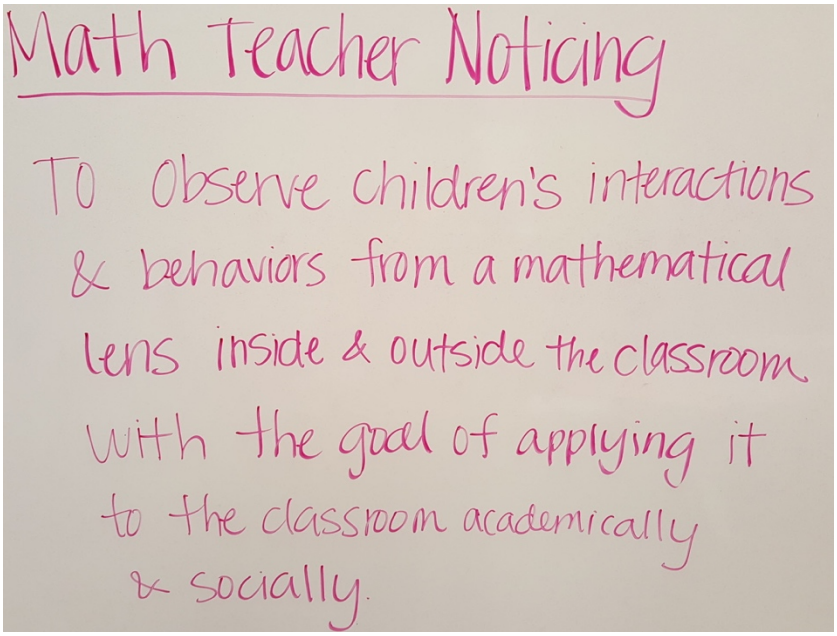

Figure 13. Co-constructed noticing definition.

- Do you think this definition captures what **you** do in your noticing that we've developed over the year (or is there more)?
- *How has your teacher noticing shaped the way you think about math? Math education?*
- *What are your thoughts about how multiple kinds of identities (such as race, gender, or age) could matter for your own teacher noticing?*
- *Why is mathematics teacher noticing important to you (and also to your future students)?*
- Challenges to math teacher noticing
- Now what? How do you hope to grow next (with math teacher noticing)?

Revisit Our Meetings (video-cued) (25 minutes)

- Preschoolers at sensory table: When you notice children, what are the first things that you see / pay attention to? What are other things you see?
- How is your noticing different now than when we first watched the video clip? [probe]

Are there any recent interactions you've had where you felt that your age, race, gender, or elementary mathematics identities were important in how the interaction happened?

- **NO**: discuss how you made sense of our discussion from last time (interaction at [science museum] with male employee) – How do you feel about your experience / what does it make you think about?

I have not had any interactions that I can think of. Since our discussion, I feel that I am now more aware of how my identities come into play when talking to others who share the same or different identities. I have also become more aware of how I respond and interact with others because of my identities. Overall, it has opened my eyes to how my identities affect my daily interactions.

IDENTITY CARDS – elaboration on process and stories

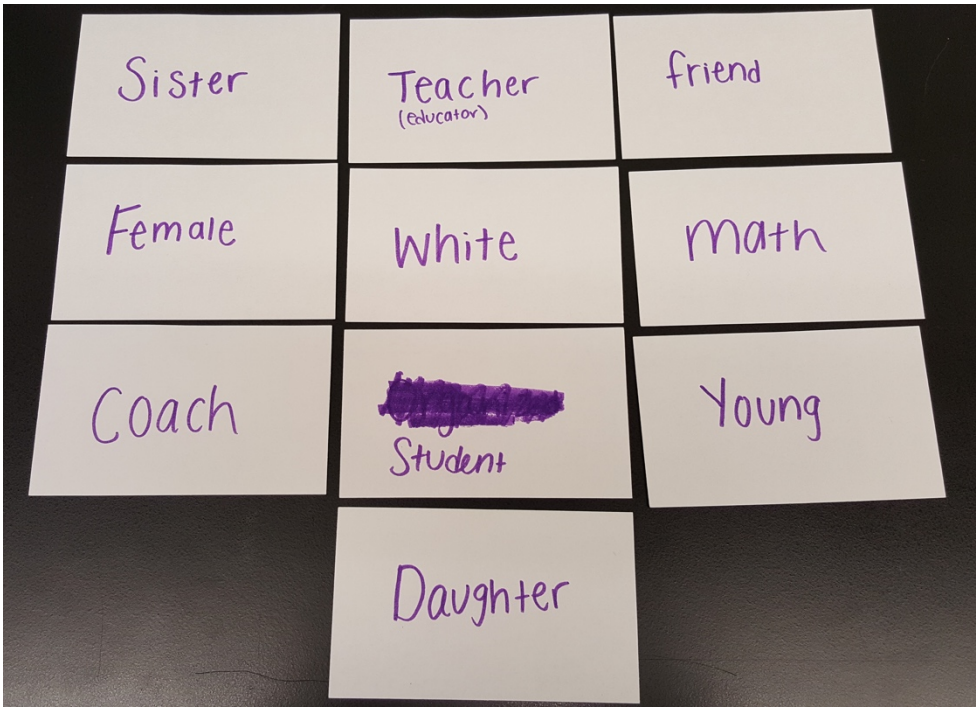

Figure 14. Ann's identity cards.

FINAL DEBRIEF OF LAST WORKING GROUP MEETING [video-cued]

FINAL COMMENTS: If there are 1-2 things that you want to make sure I write about…

- SCIENCE MUSEUM [1-page handout for member checks]

Prospective teachers also invoked narratives about age, and in particular, being young women in mathematics spaces even through our professional teacher noticing activities. In the following, two prospective teachers and the author debriefed an interaction between Ann, Lynette, and a male employee at a science museum site visit where we engaged in our noticing.

Kate: …so much of what he says is kind of condescending. Did he know you were elementary educators at this point [in the interaction]?

Lynette: At this point he did.

Kate: Yeah, and part of it—I don't know if this is applicable, but is he older?

Lynette: Yeah.

Kate: So I don't know if age is—just treating you like, "oh, you're just these young people"—and I feel just how he talks down on everything, it definitely seems a little gendered. A little ageist, maybe. Like, something's going on here. You would think that most people would be welcoming, but he was kind of the whole time not really treating you like [what

you were doing] was anything important, which isn't really good at all.

Ann: Well, I definitely felt the whole ageist thing when he realized that I was an undergrad, and at that part where I said, "No, we're observing together." …He kind of looked at me like, "well, you're just her guinea pig, you're just here for her," and it's like, no, we're here. We're working together. I don't know. He just really rubbed me the wrong way.

Lynette: So did you feel like this interaction was gendered also for you?

Ann: Yeah. Yeah. I felt like it was very much him talking down to us. He's like, "Well, I'm a male physicist and you're just elementary ed, teaching little kids. You don't know anything." … After all that time that he kept going on about what he knows and then he kept bringing up himself how he didn't know [elementary mathematics] things, but then never started acting like—he always acted like he knew better than us, even saying, "Well, I didn't even know that." Yeah, because you don't do elementary.

This example is one experience in which gender, age, and elementary mathematics content intersect in how these prospective teachers experienced identities in their world and through their learning to notice children's mathematical practices. This positioning speaks to marginalization as *females* in traditionally male-dominated spaces, as *young people* who are devalued as not having enough expertise, and as *elementary mathematics educators* who are devalued in favor of people who work with more "advanced" and "difficult" mathematics content.

APPENDIX G:

Idea Mapping Facilitation Guide

What are we (as individuals) taking away and how are these ideas connected (or not)?
How do we make sense of our *complex and contradictory* ways of knowing?

- *Stories we tell about ourselves, about children, and about mathematics*
- Masculinities in mathematics / gendered mathematics
- Hierarchies of 'mathiness' – i.e., elementary math is not 'real' math or is lesser than 'advanced' math (everyone can count and see shapes, but not everyone can do algebra or write mathematical proofs)
- Experiences: women who may be pushed into STEM/math; math teaching profession potentially seen as a "waste of that math talent"
- Identity narratives are what society thinks
- Treat the students as individuals
- Mathematics tracking
- If you just work harder, you can achieve in mathematics
- Working hard (but is it enough?) / tracking
- Mindset / intelligence is not fixed
- Individualism / ignoring or putting aside identities (to not "get in the way" of success)
- What happens when we ignore? What does that do to us and our students?
- Innateness of mathematical ability / math person
- Math teacher noticing?
- Problem posing / imposition of math (problems)
- Children & people (who do/use math) – all of us
- Is it the same math as school math? (And does it matter?)
- 'Informal' settings + mathematics
- Play (+ mathematics)
- Making math 'fun' / not painful (don't even know we're doing math!)
- Does it matter if we 'know' or realize we're doing math?
- Mathematics (plural)

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