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Taking the Sociopolitical Turn in Postsecondary Mathematics Education Research

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Abstract In this paper, we argue for a need to attend to issues of equity in postsecondary mathematics education. In the United States, the broader mathematics education field has begun a shift toward attending to sociopolitical aspects of research, which focus on the interrelatedness of knowledge, identity, power, and social discourses. We argue that explicit uptake of sociopolitical perspectives has the potential to offer new insights to current research and to advance efforts to address inequities in meaningful and theoretically well-informed ways. Situating our argument within the social and political context of the United States, we draw on existing studies that examine inequities in undergraduate mathematics classrooms. We highlight studies that focus on the impact of social discourses and institutional contexts on the negotiations of power and identity in postsecondary mathematics. We end by proposing future research directions and discuss challenges for equity work in postsecondary mathematics education.

Keywords Equity · Postsecondary mathematics · Sociopolitical perspective · Identity · Power

Issues of equity are becoming increasingly pressing in the political landscape and national discourse in the United States. In particular, various forms of professional and economic opportunity are intertwined with issues related to race and gender. Evidence of these relationships spans contexts ranging from trends in police brutality and incarceration (Chaney and Robertson 2013; Pettit and Western 2004) to pay

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disparities (Council of Economic Advisers Issue Brief 2015) to underrepresentation of particular demographic groups in professions that provide economic stability (Fox 1996; Mattis 2007).

There is a need for many more candidates for jobs in the areas of science, technology, engineering, and mathematics (STEM) than the United States is currently able to produce (PCAST 2012; Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline, Engineering Committee on Science [and Public Policy], and Policy and Global Affairs 2014). These jobs represent one path to stable sources of income, and historically marginalized groups (e.g., women, many racial minorities) continue to be underrepresented in STEM professions (U.S. Department of Commerce, Economics and Statistics Administration 2011). One important contributing factor to this underrepresentation arises from the failure of postsecondary institutions to effectively meet the needs of students from historically marginalized groups. For example, mathematics courses such as algebra and calculus often function as gatekeepers in the STEM pipeline (Adelman 2006; Boaler and Greeno 2000; Rasmussen et al. 2014; Stinson 2004).

Policy makers have argued for the adoption of more equitable instructional practices as a way to broaden the pool of STEM candidates in order to maintain U.S. national security and global economic competitiveness (PCAST 2012). Scholars who have focused on the significance of race in education (particularly that of Black[1] students) have cautioned against the danger of the capitalistic and xenophobic nature of this narrative and how it often ignores the agency and needs of students themselves (Berry 2015; Martin 2013). Recognizing the historical and contemporary issues of social justice in the U.S., we join other researchers who have argued that there exists an ethical and moral imperative to provide equal opportunity for STEM education for all students (Herzig 2004; Martin 2013; Ong et al. 2011). We centralize the needs and concerns of students in acknowledging and addressing educational inequities, instead of solely focusing on the way diversity would benefit the broader society.[2]

One symptom of the breadth of inequities in postsecondary mathematics education is the lower rates of representation of various demographic groups in academia as compared to their representation in the U.S. population. A country's demographic composition contextualizes discussions of equity, and local histories shape the arc of opportunities experienced by particular groups, which are in turn reflected by rates of representation in various settings.[3] In this article we focus on equity issues related to race/ethnicity and gender in mathematics education in the U.S. For example, as of 2012, Black, Latinx,[4] Native Alaskan, Hawaiian, and Native American students altogether comprised only 20% of Bachelor's, 18% of Master's, and 8% of Doctorate degrees in mathematics (National Science Board 2014). In contrast, these groups

[1] Berry (2015) uses the term "Black" to acknowledge the Black Diaspora, and to highlight the common way that Black learners, regardless of their origin are racialized in the U.S.

[2] Similar tension has been discussed about the inclusion of racial minorities in the classroom for the benefit of White students (Isler 2015).

[3] The importance of context makes it challenging to discuss cross-national equity issues in one article.

[4] "Latinx" is a gender-neutral term to describe to describe people with Hispanic and/or Latin American origins. The term deemphasizes implicit gender binaries in "Latina/Latino," and hence is more inclusive of transgender and other non-binary gender identities. Ramirez and Blay (2016) discuss the origin and different perspectives on the use of "Latinx" in scholarship, activism and journalism.

comprised approximately 30% of the US population (Humes et al., 2011). If represented equitably, there would have been about 1.5 to 4 times as many of these students at these respective levels of STEM education. At the faculty level, the latest Conference Board of the Mathematical Sciences survey of mathematics departments in the United States shows people from these same groups comprised only 9% of all full-time mathematics faculty (Blair et al. 2013). Black, Latinx, Native Alaskan, Hawaiian, and Native American women represent only 3% of the total full-time mathematics faculty whereas 29% of full-time mathematics faculty members are women. This highlights the ongoing dearth of female faculty and faculty of color in mathematics.[5]

In this paper we argue that there is a pressing need for research to attend to equity issues at the postsecondary level. We also make a case for postsecondary mathematics education research to take the *sociopolitical turn* in mathematics education to advance this work (Gutiérrez 2013). The sociopolitical turn reflects a growing body of work in mathematics education, which foregrounds issues of power and politics in research. Sociopolitical perspectives highlight the interrelatedness of knowledge, power, identity, and ways that these are situated within and influenced by broader social discourses (Gutiérrez 2013). The central claim of this paper is that sociopolitical perspectives offer insights that have the potential to advance research on equity issues at the postsecondary level. In the next section, we specify what we mean by equity and discuss core aspects of sociopolitical perspectives, including particular conceptualizations of knowledge, power, identity, and discourses.

Conceptual Frameworks

Distinguishing Equity from Equality

We conceive of equity research as research that explicitly focuses on efforts to understand and mitigate systemic differences in ways that people experience and are afforded educational opportunities, particularly differences that privilege one group over another (Gutiérrez 2002, 2013). This definition includes research that more commonly focuses on examining differences in students' *access* to resources and opportunities and their *achievement* outcomes. However, efforts to understand the full complexity of educational inequities also require careful examination of the impact of *identity* and *power* on these differences (Gutiérrez 2009). That is, an important goal of equity research is to understand the ways that students negotiate the meaning of membership in different social groups (e.g., gender and ethnic groups) and the influence of those negotiations on their educational experiences. Equity research also examines ways that students negotiate authority and control of resources with other stakeholders in their educational experiences. Gutiérrez (2009) considers access, achievement, identity and power as four important components of equity.

We distinguish the goal of equity, which focuses on justice, from equality, which focuses on sameness (Gutiérrez 2002). Sameness refers to a response to inequities that

[5] Walker (2014) has documented the formative and educational experiences that contribute to the success of a small number of Black mathematicians, in addition to highlighting the many and multiple obstacles that may contribute to the under-representation of Black faculty members.

prioritizes treating all students the same regardless of their backgrounds. This kind of context-free[6] approach to address inequities does not take into consideration the critical roles students' backgrounds and identities have played and continue to play in their experiences in education. Gutiérrez (2002) asserted, "To redress past injustices and account for different home resources, student identities, social biases, and other contextual factors, students, in fact, need different (not same) resources and treatment to reach fairness" (p. 152). Context-free approaches ignore these factors and hence continue to privilege the identities and practices of students from the dominant group.

A Shift Towards Sociopolitical Perspectives

In the last couple of decades, there has been more consideration of sociocultural theories about the teaching and learning in mathematics education research, corresponding to what Lerman (2000) has described as the *social turn* in mathematics education. In addition to framing knowledge construction as a result of social interaction, Valero (2004) highlighted the importance of culture and traditions of social spaces as important aspects of contexts that also need to be accounted for in learning. Vygotsky's ideas and the more recent work of Lave and Wenger (1991) are examples of sociocultural theories that have been taken up by the mathematics education community as part of the social turn. In undergraduate mathematics education research, many have drawn on and extended Cobb and Yackel's (1996) efforts that go beyond purely cognitive approaches. For instance, Stephan and Rasmussen (2002) examined ways of reasoning that become normative through social interaction in an inquiry-oriented differential equations class. Rasmussen et al. (2015) utilized and elaborated on Cobb and Yackel's (1996) *interpretive framework* in the undergraduate context to offer a more robust account of the both the social and individual processes that contribute to students' mathematical progress.

Lerman (2000) and Valero (2004) posited that considerations and broader acceptance of sociocultural perspectives were in fact motivated by political concerns in mathematics education. They argued that the recognition of systematic exclusion of some groups of students from opportunities to learn mathematics led many researchers to social theories of learning as a viable alternative to cognitive theories. Thus, a decade ago, Valero (2004) made a case for a burgeoning trend of studies that take a *sociopolitical perspective.* Beyond considering the social aspects of education, Valero (2004) noted that an increasing number of studies focused on issues of power in mathematics education. In particular, she argued that these studies were both political and social because they challenged dominant understandings of the contents and processes of learning mathematics, and investigated the roles mathematics and mathematics education play in positioning students in a social hierarchy.

Importantly, these studies, and sociopolitical perspectives more broadly, highlight the potential of mathematics education to challenge such a hierarchy. Nearly a decade after Valero (2004), there appears to be a broader shift in the field to attending to

[6] We use the term "context-free" instead of "colorblind" or "genderblind" to describe the lack of attention to people's backgrounds. The term "colorblindness" has been useful in describing beliefs about freedom from racial bias and has led to powerful critiques about such beliefs in a racialized society (Bonilla-Silva 2003). However, the terms discriminate against people with visual disabilities by erasing or delegitimizing their existence and experiences (Colorblind 2011).

theories that examine social and political issues about the knowing and learning of mathematics (Gutiérrez 2013). Evidence of the uptake of sociopolitical perspectives includes the 196 citations (per Google Scholar) in less than four years since this paper by Gutiérrez (2013).

Sociopolitical Perspectives in Mathematics Education

Gutiérrez (2013) explains that adopting a sociopolitical perspective involves considering knowledge, power and identity as "interwoven and arising from (and constituted within) social discourses" (p. 40) (see Fig. 1). Here, we detail what we mean by power, identity, and their relation to knowledge and social discourses.

From this perspective, discourses are not limited to uses of speech and words in a particular context such as classroom discourse (Cazden and Beck 2003) or mathematical discourse (Lampert, Rittenhouse, & Crumbaugh, 1996), but rather as including:

> institutions, actions, words, and taken-for-granted ways of interacting and operating. So, in some ways, discourses can be thought of more like paradigms in which we operate. Discourses reflect a particular point in history, including specific relationships between people, knowledge, and agency; they come to define what we think of as 'normal' (Gutiérrez 2013, p. 43)

The achievement gap between minority students and White students is an example of a prominent social discourse in U.S. mathematics education (Gutiérrez 2013). Surveys and studies repeatedly report on the gap, which in turn lead to a normalizing of this fact. We return to this idea shortly.

Studies that adopt a sociopolitical perspective focus on investigating "accepted" norms and practices within the field of mathematics that privilege some people while excluding others. Part of this effort includes investigating the politics of knowledge as seen in the way society treats certain kinds of knowledge and practices as more

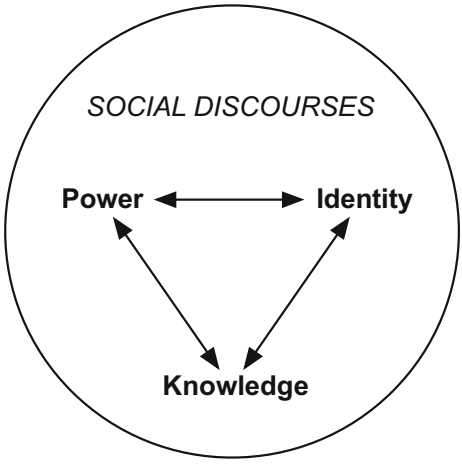

Fig. 1 Components of a sociopolitical perspective

legitimate than others (Apple 1992; Gutiérrez 2013). Investigating the politics of knowledge also necessitates more dynamic perspectives on power and identity.

Considering a sociopolitical perspective involves recognizing the complexity of identity and power and ways that they influence students' experience in learning mathematics. One common way to conceptualize identity is in terms of a group membership (e.g. Asian, female, professor). From a sociopolitical perspective, this is problematic because it leads to a perception of members of these groups as monolithic, and thus their membership functions as a static (cultural) marker (Gutiérrez 2013). This tendency to reduce variance and diversity within a group of people into a category of membership also brings with it a danger of *essentializing*. Essentializing is the act of attributing an observed pattern in behavior from members of a particular group to be a trait of that particular group (e.g., all Black students think this way).[7]

Esmonde (2009) highlights the complexity of the construct of identity by highlighting its dynamic and situated nature in the ways it has been conceptualized in mathematics education:

> Whether identity is conceptualized as a set of beliefs about oneself (Martin 2000), as a subject position in relation to other people within a practice (Walshaw 2005), or as a narrative told about oneself (McAdams and Bowman 2001; Sfard and Prusak 2005), one's identity changes within the context of a practice as one becomes adept at that practice (or as others become adept) (p. 1012).

Each conceptualization highlights identity as dynamic in its negotiation and evolution in interaction. For example, a student can position themself as a capable doer of mathematics (projecting a strong mathematical identity), but a classmate or a teacher can position that student as incapable. How the student resists or acquiesces to how others position them are ways a person can negotiate identity through interaction.

This example also highlights ways that identity is co-constructed through positioning and power relations (Gutiérrez 2013). Gutiérrez (2013) and Valero (2004) argue for shifting away from a Marxist view of power and toward a more fluid and situated perspective. Power is not just "the capacity of some people– or groups of people– to keep others in their condition of excluded [sic]" (Valero 2004, p. 10), but also "a relational capacity of social actors to position themselves in different situations and through the use of various resources" (Valero 2004, p. 11). Thus, in addition to examining formal power structures such as those that exist in governmental or educational institutions, it is also important to acknowledge and investigate the power that actors such as students, teachers, and administrators have to negotiate, challenge and/or resist existing discourses.

[7] Gutiérrez and Rogoff (2003) have discussed the danger of essentializing in studies about learning. This problem often arises from an unwarranted (and potentially dangerous) assumption that learning characteristics are linked with genetic traits. The authors propose *cultural ways of learning* as a more productive way of making sense of observed patterns in learning as "proclivities of people with certain histories of engagement with specific cultural activities" (p. 19).

Fixations on the Achievement gap: An Illustration of a Sociopolitical Perspective

A discussion about research around achievement gaps can help illustrate salient aspects of a sociopolitical perspective. Many studies at the K-12 level in the United States have focused on the disparity in achievement outcomes between groups of students when disaggregated by race and gender.[8] Gutiérrez and Dixon-Román (2011) also highlighted this pattern outside of the United States with international comparative studies. Much effort and attention have been given to identifying such disparities and closing these gaps (Gutiérrez 2008). For example, researchers often note the differences between the achievement outcomes of White students and those of racial minority students or of men and women. Adopting a sociopolitical perspective involves examining the implications of this racialized and gendered fixation on achievement outcomes (Martin 2000, 2013).

Studies framed in terms of achievement gaps can perpetuate existing narratives about a fictitious racial and gendered hierarchy of ability in mathematics (Gutiérrez 2013; Gutiérrez and Dixon-Román 2011; Martin 2013). Thus achievement gap studies inadvertently normalize a deficit perspective on students from non-dominant groups, which focuses on their relative underachievement in mathematics (Gutiérrez and Dixon-Román 2011; Harper 2010). Because "achievement gaps" are typically identified through students' performance on assessments developed to reflect the knowledge (and ways of expressing that knowledge) valued by the dominant group, they privilege the dominant culture into which marginalized students are expected to assimilate (Gutiérrez 2013). These tendencies highlight the political nature of knowledge and the importance of social discourses in the positioning of students and research subjects.

By tying students' achievement data to static markers of their identity (demographic characteristics), these studies offer a very limited understanding of inequities and how they develop. Such studies also fail to acknowledge differences in access to learning opportunities among members of marginalized groups (Gutiérrez 2008). Moreover, by focusing solely on group membership as indicators of students' identities, these kinds of studies do not typically examine issues of agency and power of students in negotiating inequities, or the impact of inequities on students' identities.

In summary, from a sociopolitical perspective, knowledge, power and identity are interrelated and arise from social discourses. This perspective focuses attention on uncovering taken-for-granted rules and values embedded in the culture of disciplines and educational institutions. Specifically research from a sociopolitical perspective seeks to understand ways that unspoken rules and values impact perspectives on knowledge, and mediate the negotiations of power and identity. To support our case about the value of a sociopolitical perspective for research in postsecondary mathematics education, we examine existing equity literature at this level.

[8] Gutiérrez (2008) noted that a Google Scholar search with the term "achievement gap" and "math" resulted in approximately 8000 hits.

Methods of Selecting Literature

To argue for the potential of sociopolitical perspectives to advance equity research in postsecondary mathematics education, we select a set of studies from the postsecondary mathematics education literature to examine. We focus on studies that examine equity issues related to students' experiences learning in mathematics classrooms. We prioritize classroom studies because classroom instruction is a major focus of work of members of the postsecondary mathematics education community. As such, we believe that the studies we have selected to be especially informative and impactful to the postsecondary mathematics education community. Our process for identifying studies to include in our discussion is detailed below.

Identifying Equity Studies in the Literature

We conducted a search of the postsecondary mathematics education literature for studies that focused on underrepresented groups' experiences in mathematics. In particular, we sought studies that focused on experiences of students from underrepresented groups at the classroom and departmental level. We started with a Google Scholar search for articles using combinations of "equity," "gender," "undergraduate mathematics," "African American," "Hispanic," "Latino," and "Native American," as common words often included in equity related research.

This initial search pointed us to a number of studies in STEM higher education more broadly (e.g., Brown 2002; Espinosa 2011; Griffin et al. 2010; Harper and Newman 2010; Price 2010; Seymour 1995; Strayhorn 2010). Most of these studies focus on university level policies and factors that can contribute to broadening access into mathematics, and increasing achievements of students from underrepresented backgrounds. For example, researchers have documented the positive impact undergraduate research experiences (Espinosa 2011; Strayhorn 2010) and strong faculty mentoring (Griffin et al. 2010; Herzig 2004) on the success of students of color in STEM. We found a limited number of studies that focus on experiences of students from underrepresented groups in postsecondary mathematics.

The next step in our search focused on exploring the references of the studies we found, and other studies that cited them. We also contacted leading equity scholars in mathematics education more broadly for names of scholars who investigate equity issues in postsecondary mathematics, particularly at the classroom level. Many of the references included in this paper were identified as a result of contacting these scholars and reviewing the reference lists of the recommended articles.

Specific Studies Highlighting the Potential for Sociopolitical Perspectives

We selected two widely recognized studies in undergraduate mathematics education to start our discussion of sociopolitical perspectives: Fullilove and Treisman's (1990) study about the Emerging Scholars Program, as well as Laursen et al. (2014) study

about Inquiry Based Learning (IBL).[9] We selected these because as we begin a discussion about equity issues in postsecondary mathematics, we posit that it would be helpful to start with conceptualizations of equity likely to be familiar to a broader set of readers: access and achievement. Both studies foreground these two components in their investigation of classroom practices linked to equitable learning opportunities. Both studies attended to issues of power by challenging deficit views of students from underrepresented groups, and by exploring aspects of the institutional context that might have contributed to inequities. Moreover, other studies have also begun investigating ways that these interventions supported productive negotiations of power and identity (Oppland-Cordell and Martin 2015; Hassi and Laursen 2015). These studies are consistent with sociopolitical perspectives in their focus on issues of power and identity when considering students' learning of mathematics.

Following this, we discuss four studies that foreground the impact of discourses on students' identities and educational experiences (Larnell et al. 2014; Larnell 2013; McGee and Martin 2011; McClain 2014). We share the findings of these studies with the broader postsecondary mathematics education community, as these kinds of studies tend to be published and shared in more equity-focused research forums. Focusing specifically on experiences of successful Black mathematics students, these studies serve as helpful examples of research that highlights the impact of institutional context and discourses on students' participation in mathematics. These studies acknowledge Black students' resilience and resourcefulness in successfully navigating the culture of educational institutions and responding to identity threats. The explicit focus on student success counters common deficit perspectives on Black students in mathematics. These studies also serve as examples of ways that research can contribute to counternarratives about Black students' participations in mathematics.

Examining Sociopolitical Perspectives in the Postsecondary Context

Exploring Equity in Instructional Practice

In this section, we draw on two relatively well-known instructional innovations that have been shown to mitigate differences in achievement between groups of students: the Emerging Scholars Program (ESP), also known as the Treisman Math Workshop, and Inquiry-Based Learning (IBL). We primarily draw on Fullilove and Treisman (1990) Laursen et al. (2014) as representatives of research on these innovations. While these studies explore disparities in outcomes, they also highlight the effects of providing access to more equitable learning opportunities for particular groups of students.

A Brief Summary Fullilove and Treisman (1990) and Laursen et al. (2014) showed that two underrepresented groups, Black students and women (respectively) were able

[9] As of the writing of this paper, Fullilove and Treisman's (1990) work has been cited 335 times. Laursen and colleagues' (2014) work is one of the first large scale quantitative studies that explores the effects of IBL on student outcomes. In recent years, there has been an increased in interest in IBL approaches as evidenced by many well-attended national conferences about this pedagogical approach.

to perform equally well as compared to their peers when given access to meaningful engagement with mathematics. The Treisman Workshop was developed in response to an observed achievement gap in calculus grades between Black students and their Chinese-American peers at the University of California (UC), Berkeley. As a graduate student, Treisman developed recitation sections that incorporated opportunities for students to form diverse communities of learners to work together on challenging mathematics problems. This design was based on his observation of the Chinese-American students' practices studying with peers from within their cultural group, juxtaposed with the apparent isolation of Black students in their studying practices. Fullilove and Treisman (1990) linked workshop participation to significant improvements on Black students' achievement in calculus, their persistence in mathematics-based majors, and graduation rates.[10]

Laursen et al. (2014) documented the effects of Inquiry-Based Learning in female students' achievement and attitudes in undergraduate mathematics. IBL is an instructional approach that focuses on providing students opportunities to engage in mathematical inquiry. The approach often involves collaboration between students as they solve problems and develop conjectures and arguments. Drawing on data from over 100 courses across four institutions, Laursen et al. (2014) found that IBL courses eliminated a gender-based gap in self-reported learning gains that existed in non-IBL courses. Moreover, interest and confidence in doing mathematics also increased for female students in IBL courses.

Learning Opportunities and Power While both Laursen and colleagues' and Fullilove and Treisman's studies investigated an achievement gap, they examined the gap through differences in opportunities to learn (Flores 2007). This contrasts with a deficit perspective arising from focusing solely on outcomes such as performance on an assessment (Gutiérrez 2008). Doing so allowed the two studies to illuminate the nature of inequities that gave rise to differences in outcomes. For example, Fullilove and Treisman's (1990) ethnographic study found that the Black students were academically isolated; most studied alone and rarely reached out to their instructors. This stood in contrast to the Chinese-American students' experiences. They had communities of learners wherein they studied together, critiqued one another's work and learned from their upperclassmen and instructors. This finding importantly guided the design of the workshop.

Neither study was explicitly framed in terms of students' identities, but both touched on issues of power by challenging existing deficit narratives about underrepresented groups of students. By showing equal, if not better outcomes for Black students and female students, respectively, Fullilove and Treisman (1990) and Laursen et al. (2014) showed that these groups of students were equally capable doers of mathematics compared to their counterparts. These studies challenged deficit narratives about Black students and women and the fictitious hierarchy in mathematics ability. Laursen et al. (2014) argued,

[10] Such findings have been replicated by other studies in different institutions. Hsu et al. (2008) provide more details on the core principles of the program, implementation, and the impact on students' achievements 30 years since the program's inception.

> That this apparent deficit can be so readily erased shows that its cause is not a *deficit* among female students, but rather that non-IBL courses do selective disservice to women. That is, IBL methods do not "fix" women but fix an inequitable course (emphasis added, p. 415).

Moreover, Treisman (1992) also documented and dispelled commonly held deficit-oriented assumptions among mathematics faculty members at UC Berkeley about Black students' low performance in calculus. These errant faculty assumptions were: lack of motivation, preparation, family support, and economic resources,[11] all of which were shown to be unfounded.

Exploring Mechanisms through a Sociopolitical Lens These findings regarding Treisman workshops and IBL approaches to mathematics instruction suggest that adopting more equitable instructional approaches can mitigate inequities in outcomes. Yet is it merely the act of providing access to rigorous mathematics problems through group discussions that better supports the learning of women and students of color? We argue that focusing on the impact of these learning spaces on the development of students' identities, and examining existing deficit narratives about students, can illuminate some of the underlying mechanisms that explain the more equitable nature of these spaces.

These instructional approaches provide different kinds of opportunities for students to develop and negotiate mathematical, racial, and gender identities. Rather than relying on broader cultural narratives or experiences outside of classrooms, a "visible and collaborative" way of engaging with authentic mathematical activity supported the development of students' identities (Hsu et al. 2008, p. 4). By focusing on identity, power, and positioning, Oppland-Cordell and Martin (2015) found that the visibility of students' mathematical work in these spaces served as an opportunity for students to recalibrate their perception of intelligence as related to race, gender and other aspects of identities. They found that in observing strong mathematical work by Black and Latinx students, Latinx students in the study recognized their own excellence in mathematics. This observation also allowed these students to challenge existing narratives about the superiority of their White and Asian peers in mathematics. Oppland-Cordell (2014) provided an example of this from a Latinx student, Vanessa:

> I was like, wow! I guess it's good to see how other Hispanic people are so good at doing math…. *It's not what people usually think of*. I think it makes me proud that there's a chunk of us, I'll put myself in that group, that are willing to do whatever to be good at math or to excel in math (emphasis added, p. 20).

This example illustrates this student's awareness of deficit narratives about groups with whom she identified as well as the positive impact of the workshop in calibrating her perception of who was capable of being good at mathematics.

[11] In a synthesis of research on women of color in STEM, Ong et al. (2011) found similar narratives continued to persist about women's underrepresentation in STEM. This is despite numerous studies having refuted the false narrative that women of color lack interest in the field as the reason for the group's underrepresentation in STEM.

Spaces like the Treisman workshop and IBL classrooms also position students differently than a traditional lecture-based classroom. As the spaces provide access to meaningful learning opportunities (e.g., problem posing and proving conjectures), they position students as active participants and constructors of mathematics. Boaler and Greeno (2000) have shown the way this can impact students' mathematical identities and future participation in mathematics with Advanced Placement Calculus students. At the undergraduate level, Yackel and Rasmussen (2002) have shown how similar classroom norms relate to students' emerging beliefs about themselves, about others, and about mathematics. While the authors did not frame this work in terms of students' identities, the analysis about beliefs regarding the roles of one's self and others are consistent with an identity framing. Similarly, Oppland-Cordell and Martin (2015) found that students in their study recounted various examples of the way that their experiences in the workshop "positively impacted how they envisioned themselves as doers of mathematics in the future" (p. 35). This contrasts with the typical positioning of students as observers or absorbers of knowledge in a more traditional classroom, which has been shown to discourage students to pursue mathematics (Boaler and Greeno 2000).

Hassi and Laursen (2015) found that the repositioning that happens in an IBL classroom, along with other aspects of IBL, had positive impact in students' "personal empowerment" (p. 318). This included their "*self-empowerment* in the form of positive self-perceptions and identity development, enjoyment, and personal agency and self-regulation; *cognitive empowerment* in the form of enhanced thinking and learning; and *social empowerment* in the form of increased social skills" (p. 318). While their sample did not allow for analysis on the impact of IBL on students of color, Hassi and Laursen (2015) reported promising findings about the impact of IBL on women.

Particular findings included that a higher percentage of women reported increased self-esteem and pride for their mathematical accomplishments compared to the men (40% vs. 24%). Women also more frequently reported increased confidence to work on mathematical problems after an IBL class compared to the men (74% vs. 59%). Here is one example quote about a female student's increased self-empowerment:

> F: [gives example of her work] I actually thought, I can do this stuff instead of just looking at notes from a professor and doing the same thing. I can actually think of stuff for myself and use the tools that they gave me to accomplish something. Whereas—probably everybody's proof in the class is similar but no one's is exactly like yours—so even if you are doing the same basic thing, you still have [the feeling that] that's my work that I can actually say is mine (p. 325).

By explicitly focusing on issues related to power, specifically personal empowerment, Hassi and Laursen (2015) illuminated some of the mechanisms underlying the affordances of an IBL classroom for students, particularly for women.

Attending to Impact of Discourses on Students' Identities

Oppland-Cordell and Martin (2015) and Hassi and Laursen (2015) alluded to the potential impact of spaces like the Treisman workshop or IBL classrooms on students'

mathematical and social identities. We now focus on research that has examined Black students' identities, and ways that students in these studies navigated the culture of educational institutions and identity threats, without necessarily having the support of the spaces we previously discussed. We highlight ways these studies consider the dynamic and situated nature of identity and power.

We discuss the work by Larnell (2013), Larnell et al. (2014), and McClain (2014) on identity and identity threats, and McGee and Martin (2011) stereotype management. We first situate this discussion relative to psychological research relating to the notion of *stereotype threat* (Steele 1997) before turning to literature documenting strategies students have developed for managing stereotype threats in undergraduate STEM.

Stereotype Threat The notion of stereotype threat provides a productive and oft-cited way of relating power and identity to issues of equity. Steele (1997) describes stereotype threat as "the threat that arises when one is in a situation or doing something for which a negative stereotype about one's group applies" (p. 614). Steele and colleagues demonstrated that, when primed to be aware of a negative stereotype about their group's ability in a particular academic domain, women and Black students underperformed relative to their male and White peers, respectively; however, absent such priming there was no difference in test performance between the two groups (Spencer et al. 1999; Steele and Aronson 1995).

Aronson et al. (1999) showed that this difference need not arise through historical marginalization nor from internalized feelings of academic inadequacy. They found the performance of White men was depressed when participants were told the test was given to examine the mathematical superiority of Asians (a common stereotype). Other studies have replicated the finding that invoking negative stereotypes is related to depressed assessment outcomes for other groups and linked these differences to reduction in working memory capacity (Schmader and Johns 2003) and even blood pressure reactivity among African Americans (Blascovich et al. 2001). Taken together, these findings suggest that the situational positioning of students in academic environments can in and of itself shape students' learning opportunities and outcomes in consequential ways. We now turn to research documenting identity-related strategies Black students have developed to cope with, counter, and/or overcome negative stereotypes in mathematics.

Responding to Identity Threats Several studies have explored ways that Black students respond to identity threats, like stereotypes in the context of undergraduate mathematics (Larnell et al. 2014; Larnell 2013; McGee and Martin 2011). Larnell (2013) defines a *threatening masternarrative* as a consistently reified and marginalizing negative message within an institutional environment about a particular group of students. The narrative about Black students' perceived inability to learn mathematics as evidenced by their overrepresentation in developmental mathematics courses is an example of a threatening masternarrative (Larnell 2013).

Larnell et al. (2014) summarized three ways that students can respond to threats to their identity that have been discussed in the literature: 1) identity infiltration / domain disidentification, 2) stereotype management, and 3) counternarratives. Identity infiltration/domain disidentification refers to the adoption of a negative masternarrative as part of one's identity. Over time students can end up conforming to a given

stereotype, which then leads to refusal to participate in mathematics as a result of the prevalence of such threat.

McClain (2014) found that some Black STEM majors simply had to cope with and compensate for the challenge of being the only Black student in mathematics classes. Without a supportive social and academic community, stereotype threats can contribute to students' isolation from peers and professors. Students in the study reported strong confidence in their mathematical skills and abilities as they transition into college, and were fully aware of benefits of collaborative learning and strong social and academic networks. However, being the only Black student in their mathematics classes heightened the threat of stereotypes on their peers' and professors' perception of them. Black students in the study were made more aware of what it meant to be Black in college, and expended energy to prove that they belonged in the class and university. These discourses constrained their active participation in their class and in office hours, which in turn prevented students from developing the necessary social and academic network. McClain (2014) highlights the influence of institutional context (e.g., underrepresentation of Black students in a classroom) in heightening threatening narratives on students' learning of mathematics.

Stereotype management refers to "the strategies high-achieving [Black] students develop and utilize to cope with the strain of being racially stereotyped while maintaining traditionally high standards of academic success" (McGee and Martin 2011, p. 1363). The authors uncovered a variety of stereotype management strategies. Study participants shared the practice of always being "on point" (p. 1365), that is, staying on top of their academic work and always being in control of situations. Many of these students reported they were motivated to do well in order to refute stereotypes. All of the students shared that their persistence was also motivated by the goal of teaching in their respective fields, and becoming role models for aspiring Black engineering and mathematics students (McGee and Martin 2011; Ellington and Frederick 2010). This finding also highlights a different way of conceptualizing "community" and its role in the students' learning.

McGee and Martin (2011) noted that success in managing stereotypes came with psychological costs. They found that over time some of these students began to devalue themselves and their academic achievements as a result of the omnipresent racialized stereotypes, suggesting the beginning of identity infiltration. At times managing stereotypes could also involve critical views of the behavior of other Black students who were not high achieving. Some of these students also engaged in cultural code-switching by emulating "acceptable" behaviors in White-middle class academic culture such as wearing "non-threatening" clothes, or smiling a lot to appear friendly. The authors reported that even with the different management strategies, the students in the study ultimately were only able to reduce the effects of stereotypes.

Related to stereotype management, Larnell et al. (2014) identified a third category of response called *counternarratives* (Solórzano and Yosso 2002). Counternarratives take on a more active resistance to stereotypes by constructing alternative stories about one's own group that refuse the coercive power of identity threats. The case study in Larnell (2013) serves as an example. Cedric, a high achieving Black student, constructed an agency-oriented counternarrative as a response to the negative masternarrative on Black achievement in postsecondary mathematics. Cedric asserted that the masternarratives actually pushed him to study harder to prove that "there are African American students

that will get a good grade in this class. That we'll succeed in this class. /…/ It pushes me more than it pushes back" (Larnell 2013, p. 153). Vanessa, the Latinx student in Oppland-Cordell (2014) offered an example of a counternarrative about one about the racial hierarchy in mathematical ability:

> They're struggling the same way I am and they're Asian…. /…/ I mean the majority they're really smart, but some of them are struggling like any other person that's here…I always thought that they were smart until I came here and I realized not everyone is as smart as they look you can say. [laughs] (Interview 3, May 12, 2008) (p. 41).

Oppland-Cordell (2014) posited that counternarratives could allow students to deconstruct and explore the validity of the masternarratives. Larnell et al. (2014) found that counternarratives have the potential of repairing "identity infiltration," a situation in which students begin to adopt or take up the identities that negative masternarratives offer (p. 51). The authors also provided examples of ways that these threats and negotiations can manifest themselves in everyday classroom settings. In the long run, McGee and Martin (2011) found that, with age and maturity, many of the students in their study developed "self-directed and self-determined identities" (p. 1373). By relying on supportive spaces where they could affirm their identities and abilities, students in the study were able to move away from omnipresent stereotype threats.

In sum, these studies serve as examples of research that foreground the impact of discourses on students' identities and practices. They illuminated the effects of identity threats, including racialized stereotypes on students' identities. Not treating identities as static markers of students, these studies were able to illustrate ways that social contexts impact the performance of identities and ways that identities are negotiated between individuals in the context of existing social discourses. By focusing on the excellence of Black and Latinx mathematics students, these studies also provided examples of ways that research can challenge existing deficit narratives and positioning of Black, Latinx, and female students in mathematics.

Discussion and Implications

Our goal with this paper is to argue for postsecondary mathematics education to embrace the sociopolitical turn (Gutiérrez 2013). Broadly, this involves more explicitly and consistently attending to equity concerns, and exploring the interrelatedness of knowledge, identity, power, and broader social discourses. We discussed a selected set of studies in undergraduate mathematics education to support our claim that a socio-political perspective can productively guide the advancement of equity research at the postsecondary level.

We drew on some specific instructional approaches that have been shown to provide more equitable learning opportunities as a context to discuss the affordances of sociopolitical perspectives. In particular, we highlighted ways that classrooms with these instructional approaches served as spaces that supported productive negotiations of identity and power in mathematics. We drew on literature documenting forms of

resilience among Black and Latinx students, challenging deficit narratives about their participation in mathematics. From a sociopolitical perspective, the focus in addressing inequities is not to "fix the students," but instead to "change at least a small part of the university environment, by making it more welcoming, both socially and academically" (Asera, 2001, p. 19). That is, the focus lies in recognizing and examining institutional culture, context, and discourses that contribute to inequities.

We caution the reader against interpreting IBL or the Treisman workshop as the context-free "silver bullet" to solve inequities in undergraduate mathematics. Laursen et al. (2014) provided evidence that IBL approach equalized important outcomes between men and women. However, when we consider equity issues, generalizability of findings from quantitative studies as a result of a large sample size is always in tension with their reliance on aggregate outcomes and averages. Attending to this tension means being mindful of the reality that the effects on each student in the study are not the same, despite the closing of any "gap" between groups. This also brings us back to the discussion about equality versus equity. Insisting on the value of equal treatment for all students ignores the systemic inequities experienced by different groups of students. The use of averages unfortunately also has the potential to deemphasize any perpetuated inequities.

This critique does not negate the power of IBL or of active learning more broadly, but instead demands the research community to look deeper. We have shown that a sociopolitical lens and its emphasis on identity and power offers insights into ways that these instructional approaches support more equitable teaching. However, more work is needed to document if, when, and how these instructional approaches are equitable for all students. How do particular forms of implementation, or instructor orientations toward students influence the equitable outcomes associated with these instructional approaches? Ladson-Billings (1995) found that, among the teachers who effectively served predominantly Black groups of students, teachers' "philosophical and ideological underpinnings of their practice," which include their thoughts on students, students' knowledge, and students' communities, served as points of convergence. This suggests that to investigate any "success" of IBL practices, research needs to investigate not just the practice itself, but also the particular instructors' orientations and instantiations. This is critical as we continue to explore potential benefits of IBL for other students from underrepresented backgrounds. Moreover, because an active learning classroom such as an IBL classroom has its own structure and thus particular power distribution, which aspects of students' identities are privileged in such a classroom, and which are marginalized? The goal is to surface these concerns and find ways to ensure that inequities are attended to rather than perpetuated.

Attending to these questions necessitates a broader understanding of student identity development in the context of different power structures, and the role that plays in students' mathematical experiences and opportunities. Such work is necessarily complex, as it needs to attend to diversity in experiences of students, including students of color and women (Hsu et al. 2008; Oppland-Cordell & Martin, 2015), and recognizing the danger of essentializing groups of students. Additionally, Hsu et al. (2008) have noted the need to consider the local context of an educational institution in implementing any instructional approach. This local context includes the students, as well as available resources and support from the department. Below we discuss some

research directions and challenges, including other open questions related to instructional approaches such as IBL or the Treisman workshop model.

We recognize that certain aspects of identities and ways they are negotiated are underrepresented in the literature. For example, there has not been as much work with and about LGBT students, and students with disabilities in postsecondary mathematics. We have only begun exploring the limitation of traditional instruction of postsecondary mathematics on students who are visually impaired (Pilgrim and Kennedy 2014). We posit that learning from the experiences of our students with disabilities can help us to find ways to be more inclusive in the classroom, while simultaneously allowing us to better understand and potentially challenge many of the "taken for granted rules" (Gutiérrez 2013) in mathematics education.

Researchers have also argued that it is critical to understand the impact of *intersectionality* of identities (Collins 2000; Crenshaw 1991). Collins (2000) argued that gender, sexual orientation, race, class and nationality serve as mutually constructing systems of oppression. A person does not experience oppression solely as a result of the color of their skin or gender, but rather race/ethnicity, gender identity, sexual orientation, social class, religion, and disability status all contribute to a person's participation in society. We join researchers who have called for consideration of this perspective and its potential insights into equity in education (Esmonde et al. 2009; Leyva 2017; Martin 2009; Ong et al. 2011). Bowleg (2008) offers some methodological recommendations to incorporate such a perspective in research.

Work around students' identities and equity work more broadly are also situated within the social and political contexts of society. As such, equity work needs to be responsive to changes in administration and policies that inevitably impact and target students with different backgrounds. Take as an example the recent increasing awareness in the United States of the impact of immigration policies on students with particular nationalities, immigration status, and country of origin. In what ways do universities respond to new policies regarding students who were protected under Deferred Action for Childhood Arrivals (DACA) legislation? In what ways do these policy changes impact our students and their participation in mathematics classrooms? Sociopolitical perspectives call for research to attend to discourses as reflected in policy changes and their impact on students' identities, including their mathematical identities.

Underrepresentation of certain populations of students can serve as an additional methodological challenge in exploring equity issues in postsecondary mathematics. For example, it can be difficult to perform analysis on the effects of an instructional approach on women of color when they are underrepresented in predominantly White institutions (PWI). While we recognize that challenge, we argue that we as a field cannot afford to ignore the issue until different groups of students are similarly represented as they are in the broader population. While our ability to conduct quantitative analyses with large sample sizes may be limited, we can still highlight and prioritize the experiences of these students in research. Alternatively, collaboration with institutions, particularly Historically Black Colleges and Universities (HBCU) and Hispanic Serving Institutions (HSI) can serve as another way to address the concern.

As Larnell (2016) has highlighted, developmental mathematics courses are important spaces to explore in terms of representation of women and students of color and the development of students' mathematical identities. In order to meaningfully take on issues of equity, we argue that research related to developmental mathematics courses

needs to be more explicitly taken up, embraced, and supported in the research in undergraduate mathematics education community. We have dedicated effort and energy into investigating inequities that exist within our immediate gatekeeper courses into STEM, like calculus (e.g., Bressoud et al. 2015). However, to what extent does the goal of increasing the number of STEM graduates overlook the inequities that are happening in developmental mathematics courses impacting a large number of students who are not going into STEM?

The tension between attending to developmental mathematics and calculus serves as an example of examining and contending with the taken-for-granted goals, assumptions and practices in postsecondary mathematics and mathematics education research. This effort involves self-reflection work by the communities involved, and asking ourselves challenging questions. For example, how does the goal of increasing the number of STEM graduates fit with the goal of empowering students to have agency about their educational aspirations?

We propose that we, as members of the research community, can be more critical of ways that equity might be relevant in our work with students and teachers. For example, sociopolitical perspectives would challenge the context-free (e.g., ignoring issues related to gender or race/ethnicity) assumption often associated with research about mathematical thinking and practices. Studies of advanced mathematical thinking share the power in defining what counts as productive mathematical knowledge and who can be a successful mathematics student (Apple 1992; Gutiérrez 2013; Nasir et al. 2008). Our research designs and theoretical frameworks position students and their contribution in mathematics in particular ways (Adiredja 2015).

Nasir (2013) recommended the inclusion of data regarding students' gender and ethnicity in studies about advanced mathematical thinking. Accounting for students' demographic information has the potential to uncover hidden narratives in our studies. Whose voice do we privilege in our presentation of our data? To what extent do our findings perpetuate or challenge existing narratives about who are capable doers of mathematics? We recognize that the inclusion of demographic information can also be interpreted as treating identity as a static marker, and has the potential to essentialize students. It is important to be critical about the goal of including such information. We also need to be careful of inadvertently removing the anonymity of our research subjects as a result of the small number of non-White students in predominantly White institutions.

Considering sociopolitical perspectives in postsecondary mathematics entails recognizing the political nature of teaching and learning of mathematics at this level. Both research and practice in postsecondary mathematics are situated within power structures and social discourses. Research drawing on sociopolitical perspectives can continue to uncover the taken-for-granted rules and values of postsecondary mathematics as an institution. We need to better understand ways that those rules and values impact our perspectives on knowledge, and mediate the negotiations of power and identity as people navigate postsecondary mathematics. While we situate our work within the social and political context of the United States, we believe that the struggle for equity and social justice is universal. While inequities in mathematics education might take other forms in different countries, we can identify, challenge, and better address these inequities by taking the sociopolitical turn in postsecondary mathematics education.

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