Routledge
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Cognition and Instruction

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/hcgi20

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To cite this article: Luis A. Leyva , Ruby Quea , Keith Weber , Dan Battey & Daniel López (2020): Detailing Racialized and Gendered Mechanisms of Undergraduate Precalculus and Calculus Classroom Instruction, Cognition and Instruction, DOI: 10.1080/07370008.2020.1849218

To link to this article: https://doi.org/10.1080/07370008.2020.1849218

COGNITION AND INSTRUCTION
https://doi.org/10.1080/07370008.2020.1849218

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Detailing Racialized and Gendered Mechanisms of Undergraduate Precalculus and Calculus Classroom Instruction

Luis A. Leyva[a], Ruby Quea[b], Keith Weber[b], Dan Battey[b], and Daniel López[b]

[a]Department of Teaching & Learning, Vanderbilt University – Peabody College of Education & Human Development, Nashville,TN, USA; [b]Department of Teaching & Learning, Rutgers University, New Brunswick, NJ, USA

ABSTRACT

Undergraduate mathematics education can be experienced in discouraging and marginalizing ways among Black students, Latin* students, and white women. Precalculus and calculus courses, in particular, operate as gatekeepers that contribute to racialized and gendered attrition in persistence with mathematics coursework and pursuits in STEM (science, technology, engineering, and mathematics). However, student perceptions of instruction in these introductory mathematics courses have yet to be systematically examined as a contributor to such attrition. This paper presents findings from a study of 20 historically marginalized students' perceptions of precalculus and calculus instruction to document features that they found discouraging and marginalizing. Our analysis revealed how students across different race-gender identities reported stereotyping as well as issues of representation in introductory mathematics classrooms and STEM fields as shaping their perceptions of instruction. These perceptions pointed to the operation of three racialized and gendered mechanisms in instruction: (i) creating differential opportunities for participation and support, (ii) limiting support from same-race, same-gender peers to manage negativity in instruction, and (iii) activating exclusionary ideas about who belongs in STEM fields. We draw on our findings to raise implications for research and practice in undergraduate mathematics education.

Prior research has explored the experiences of historically marginalized students—namely, Black students, Latin*[1] students, and white women – to capture an ethos of marginalization in undergraduate mathematics classrooms (e.g. McGee & Martin, 2011; Oppland-Cordell, 2014; Rodd & Bartholomew, 2006). However, student perceptions of instruction that contribute to this ethos are yet to be systematically examined. Pursuing such research orients the field to mechanisms in instruction that shape racialized and gendered classroom experiences. With instruction situated in broader sociohistorical realities of mathematics education, an analysis of historically marginalized students' perceptions of instruction through an equity lens can shed light on ideological and institutional forces that produce marginalizing instructional mechanisms.

This is a critical line of inquiry to be pursued in precalculus and calculus courses, which were not the focal contexts in prior work on students' classroom experiences. In a recent review of calculus research, Larsen et al. (2016) highlighted the void of studies about "what is happening in calculus classrooms" (p. 546), including instruction. The review also acknowledged an absence of inquiry in these introductory mathematics courses that prioritizes issues of equity, with Uri

CONTACT Luis A. Leyva luis.a.leyva@vanderbilt.edu Department of Teaching & Learning, Vanderbilt University, PMB 230, GPC; 230 Appleton Place, Nashville, TN37203-5721, USA.

[1]*Latin** is a term that encompasses fluidity of social identities. The asterisk considers variation in self-identification among people of the Latin American diaspora and origin (Salinas, 2020). *Latin** responds to (mis)use of *Latinx*, a term reserved for gender-nonconforming peoples of Latin American origin and descent (Salinas & Lozano, 2019). Student participants in our study self-identified as either Latina women or Latino men.

Treisman's work over 25 years ago (Treisman, 1992) as the only cited example. Furthermore, precalculus and calculus are largely responsible for weeding out historically marginalized students in mathematics (Ellis, Fosdick, & Rasmussen, 2016; Larsen, Marrongelle, Bressoud, & Graham, 2016; Leyva, 2016). In arguing for the importance of equity-oriented calculus research, Larsen et al. (2016) acknowledged not only how a vast number of students take these courses, but also how "university calculus is such an important part of STEM education and still often acts as a barrier to students' academic progress in these areas" (p. 546). Thus, research that centers historically marginalized students' views of precalculus and calculus instruction holds significant promise in informing equitable, socially affirming classroom practices, which broaden opportunities for student persistence in mathematics coursework and STEM majors.

This paper addresses the need for such research by presenting findings from a qualitative study of 20 historically marginalized students' perceptions of undergraduate precalculus and calculus instruction at a large, public research university in the northeastern U.S. We focused on investigating mechanisms in instruction that Black students, Latin* students, and white women perceived as a source of racial and gendered marginalization. In particular, we attended to how participants perceived mechanisms as functions of systemic influences in mathematics education that shaped racialized and gendered experiences. This paper presents findings to address the following research questions:

1. What ideological and institutional *influences* shape historically marginalized students' perceptions of precalculus and calculus instruction as oppressive?
2. What racialized and gendered *mechanisms of instruction* do historically marginalized students perceive to be operating as a function of these influences?

We raise implications for research and practice based on our findings to disrupt the racialized-gendered impact of undergraduate precalculus and calculus instruction.

Detailing whiteness and patriarchy at ideological and institutional levels of experience in undergraduate mathematics classrooms

To frame our analysis, we draw on two frameworks in mathematics education: one for detailing whiteness (Battey& Leyva, 2016) and one for detailing patriarchy (Leyva, in press). Whiteness is a set of ideologies (i.e. interrelated, commonly shared beliefs and values) that maintains white supremacy, or the systemic maintenance of white people's social dominance and privilege in the U.S. (Leonardo, 2004). In addition, whiteness upholds antiblackness, a paradigm that organizes institutional and behavioral practices that dehumanize Black peoples for the maintenance of white supremacy (Dumas & Ross, 2016). Patriarchy is the systematic maintenance of sexism as well as men's social dominance and gendered privilege (Hooks, 2004; Lorde, 1984). These frameworks are appropriate for framing our analysis because they address both ideological and institutional influences of racial and gendered oppression in mathematics education. Table 1 presents the ideological and institutional dimensions of both frameworks, including their characteristic elements and everyday indicators.[2]

To capture the utility of these frameworks' dimensions, we elaborate on them using illustrative examples of everyday indicators from research on historically marginalized students' undergraduate mathematics classroom experiences. We conclude by depicting the synergy between the two

[2]We recognize the interplay of racial, gendered, and other systems of power in mathematics education that shape historically marginalized students' experiences of intersectional oppression (Bullock, 2018; Joseph, Hailu, & Boston, 2017; Leyva, 2016). Since our study was not designed to document issues of intersectionality (Crenshaw, 1991), Table 1 outlines parallels between the race- and gender-specific frameworks.

Table 1. Ideological and institutional dimensions of frameworks on whiteness and patriarchy in mathematics education.

Dimensions	Characteristic elements	Race-based indicators (Battey& Leyva, 2016)	Gender-based indicators (Leyva, in press)
Ideological	Discourses	Mathematics as neutral and culture-free	Mathematics as gender-neutral and disembodied
		Mathematical ability as innate and colorblind	Mathematical ability as innate and gender-neutral
		Racial hierarchy of mathematical ability	Gendered hierarchy of mathematical ability
Institutional	Organizational logic	Invisibility and hypervisibility of Black and Latin* students	Underrepresentation of women and girls in advanced mathematics
		Racialized distribution of mathematical authority	Gendered access to content and teacher support

dimensions to address the void of research that characterizes racialized and gendered aspects of precalculus and calculus instruction.

Discourses: stereotypes and the culture of undergraduate mathematics

A shared characteristic element of the frameworks' ideological dimensions is discourse (see Table 1). Broadly, *discourses* are ways of communicating with ourselves and with others in social contexts (Gee, 1990/2015). In mathematics education, discourses structure opportunities for mathematical participation in and beyond classrooms (Wagner, Herbel-Eisenmann, & Choppin, 2012). The following two sections define and provide examples of racial and gendered discourses in mathematics education.

Racial discourses

Racial discourses have a racialized dimension that structures inequitable opportunities for participation among Black and Latin* students. As an illustration of a racial discourse, consider *colorblindness*. The colorblindness discourse is a way of communicating the ideology that mathematics is a body of knowledge independent of culture and race, so there is no need to attend to racism or student race in teaching mathematics (Battey& Leyva, 2016; Bonilla-Silva, 2003). This discourse permits instructors and institutions to ignore inequities in mathematics education that Black and Latin* students face, further limiting support for mathematical participation.

The colorblindness discourse shapes ideas of mathematical ability as innate, which conveys messages to Black and Latin* students that if they struggle with mathematics, it is because they lack the ability to succeed and do not belong (Leyva, 2016; Martin, 2009). For this reason, we maintain that the colorblindness discourse is an instance of whiteness and antiblackness in mathematics education (Battey & Leyva, 2016; Martin, 2019), abdicating instructors and institutions of working toward racial equity for mathematical participation. If unchallenged, colorblindness gives rise to other racial discourses, including a *racial hierarchy of mathematical ability* (Martin, 2009).

This discourse of a racial hierarchy shapes stereotypes that Black and Latin* students innately lack such ability (McGee, 2016). Such stereotypes produce instructors' explicit and implicit biases that Black and Latin* students are not capable of learning mathematics, thereby limiting access to high-quality, supportive instruction (Battey et al., in press ; Copur-Gencturk, Cimpian, Lubienski, & Thacker, 2020). The hierarchy discourse can also lead Black and Latin* students to feel that they do not belong (Oppland-Cordell, 2014; Spencer, 2009). McGee and Martin (2011) illustrate how the prevalence of racial stereotypes caused undergraduate Black mathematics students to face lowered academic expectations, limited opportunities to participate, and explicit discouragement of STEM persistence.

Additionally, the discourse of a racial hierarchy of ability can interact with the culture of competition in mathematics to perpetuate racialized opportunities for success in undergraduate

classrooms (Leyva, in press; McGee, 2013; Oppland-Cordell & Martin, 2015). McGee (2013), for example, noted how such a competitive culture limited an undergraduate Black woman's mathematical success at a research-intensive university. Because instruction was framed as "drill and kill," mathematical work was a solitary endeavor with accuracy and speed as markers of ability. As a result, the Black woman experienced limited opportunities for collaborative support and classroom participation, which were further risky for her due to managing racial stereotypes of mathematical ability.

Gendered discourses

Discourses of *gender neutrality* (Esmonde, 2011) and *disembodiment* (Rubel, 2016) in mathematics marginalize women and gender-nonconforming individuals. Analogous to the colorblindness discourse, these gendered discourses permit instructors and institutions to ignore inequities in mathematics education that women and gender-nonconforming individuals experience, limiting support toward gender equity in mathematical participation (Leyva, 2017, 2019).

These discourses that perpetuate sexism and undermine students' gender identities intersect with the discourse that mathematical ability is innate, conveying messages to women who struggle with mathematics that they inherently lack ability to succeed and do not belong (Mendick, 2006). When these gendered discourses are left unchallenged, they contribute to the discourse of a *gendered hierarchy of mathematical ability* that attributes men's strong achievement and representation to inherently being more mathematically able than women (Leyva, 2017). This discourse reinforces normal' (i.e. masculine) ways of participation (e.g. competitiveness) that limit women's participation and access to building robust mathematics identities (Barnes, 2000; Rodd & Bartholomew, 2006).

In undergraduate mathematics classrooms, gendered discourses shape stereotypes of ability that lower expectations of women's mathematical potential and cause women to feel as if they do not belong. Further, these stereotypes can lead women to feel invisible because their contributions are less valued, thus creating pressure to prove themselves as exceptions to gendered stereotypes (McGee & Bentley, 2017; Rodd & Bartholomew, 2006). In addition, the competitive culture of mathematics premised on success as an individual endeavor and centered on accuracy or speed further limits different forms of participation, which is especially impactful for women who are already underrepresented. Even when women are traditionally successful (e.g. earn high grades in calculus), they must still navigate gendered stereotypes of mathematical ability that limit opportunities to participate and embrace femininity in undergraduate classroom spaces (Solomon, 2007).

While we discussed racial and gendered discourses separately, we recognize how their interplay shapes undergraduate mathematics classrooms as racialized-gendered spaces. Borum and Walker (2012) write, "Mathematics is historically a White male-dominated field, so the norms or standards originally created center on the ideologies of that specific group. Therefore, building structures that alleviate the norms of a mathematics culture… is necessary to increase the participation of these groups [women and racial minorities] in mathematics" (p. 374). Thus, white men's historical domination in mathematics influenced discourses in the field, including interactional patterns about who has mathematical ability and what types of participation are acceptable. These discourses, thus, shaped contemporary norms in mathematics, such as competition, working alone, and relying on one's natural ability.

To illustrate these norms' marginalizing potential, Borum and Walker (2012) documented how peer collaboration and faculty mentorship, which were critical to Black women's mathematical persistence, ran counter to white, masculine norms of participation. Norms of competition and working alone thrived in mathematical spaces, causing Black women to have limited access to these relational sources of support. Instruction, thus, plays a major role in either reinforcing white, patriarchal discourses that maintain a culture of isolation and fictive hierarchy of ability *or*

dismantling them to broaden opportunities for support, persistence, and recognition of ability (Leyva, in press).

Organizational logics: access and representation in undergraduate mathematics

Another shared element across the frameworks in Battey and Leyva (2016) and Leyva (in press) is the organizational logic of institutional contexts in mathematics education (Table 1). We extend Acker's (1990) gender-specific definition of or*ganizational logic* as an organization's shared set of underlying assumptions about gender *and* race as well as institutional practices rooted in these assumptions. Acker (1990) and Moore (2008) analyzed how organizations' assumptions of gender neutrality and colorblindness led to inequitable practices in the workplace (e.g. gendered hiring into high-status jobs) and law schools (e.g. racialized rates of admissions), respectively. An illustrative example of an organizational logic in mathematics education is the use of mathematics courses, including precalculus and calculus, to weed out students who lack ability and are 'not cut out' for STEM (Ellis, Kelton, & Rasmussen, 2014; Gasiewski, Eagan, Garcia, Hurtado, & Chang, 2012). This logic, rooted in colorblind and gender-neutral views of mathematical ability, intersects with racialized-gendered educational inequities to contribute to the function of P-16 mathematics courses as gatekeepers to more advanced coursework and STEM careers. Our analysis, thus, attends to how such organizational logics of mathematics education reinforce racialized and gendered inequities through precalculus and calculus instruction.

Underrepresentation of Black and Latin* students in undergraduate mathematics courses is at least partly a consequence of racialized organizational logics. Berry (2008) and Leyva (2016) have illustrated how institutional practices bear responsibility for such issues, which organizational logics explain away, through the colorblind discourse, that mathematical ability is innate. For instance, prior to college, Black and Latin* students are more likely to be tracked into lower-level mathematics courses and less likely to receive high-quality mathematics instruction, which results in a racialized distribution of mathematical authority and future access to undergraduate calculus. Tracking and racialized access to advanced mathematics is then explained as being due to innateness of ability, thus institutionally perpetuating the gatekeeping logic of mathematics courses. Analogously, underrepresentation of women and girls in advanced mathematics is an indicator of a gendered organizational logic operating. Institutional practices, such as gendered trends of course recommendations and distribution of authority in classrooms, lead to this underrepresentation (Boaler, 1997; McGraw, Lubienski, & Strutchens, 2006), which is explained away through discourses of gender neutrality and innateness of mathematical ability. These practices, thus, maintain a gatekeeping logic that reproduces gendered inequities of access to high-quality mathematics learning and support.

Racialized and gendered organizational logics of undergraduate mathematics education are maintained through gatekeeping institutional practices, such as academic advising and placement testing, that result in the underrepresentation of Black students, Latin* students, and white women in calculus (Larnell, 2017; Leyva & Alley, 2020). This underrepresentation has been documented to result in two major consequences. First, historically marginalized students question their belongingness in mathematics. For example, Borum and Walker (2012) found that Black women's isolation in undergraduate mathematics at predominantly white institutions contributed to experiences of being singled out and advised to switch out of mathematics by professors, which implicitly communicated racialized-gendered messages of not belonging.

Second, underrepresentation limited opportunities for *same-race, same-gender peer support*, or support from peers of the same race and/or gender. Such support through peer networks has been documented as critical to historically marginalized students' success in undergraduate mathematics (Ellington & Frederick, 2010; Fullilove & Treisman, 1990; Oppland-Cordell & Martin, 2015). Uri Treisman's calculus workshop model of instruction, for example, fostered same-race

peer networks that advanced Black and Latin* students' study skills and social support (Fullilove & Treisman, 1990). More recently, Oppland-Cordell and Martin (2015) found that Latin* students' participation in socially diverse calculus workshops increased supportive interactions with peers in and out of their race-gender groups, which challenged internalized stereotypes about ability that initially limited such intergroup interactions. These insights from prior research point to the importance of detailing how introductory mathematics course instruction perpetuates or mitigates the influence of organizational logics on undergraduate classroom experiences.

Framing the analysis

To ensure clarity above, we separated the presentation of ideological and institutional dimensions of the two frameworks that guided our analysis. However, these dimensions are interconnected in capturing the racialized and gendered functions of mathematics education, including classroom instruction. To illustrate, the discourse of a racialized-gendered hierarchy of mathematical ability shapes instructors' beliefs about students that impact access to learning opportunities through instruction. Organizational logics lead to racial and gendered underrepresentation in classrooms (i.e. the proportion of Black students, Latin* students, and white women in U.S. advanced mathematics is lower than in the national population). Such underrepresentation tax Black students, Latin* students, and white women with the burden of approaching classroom participation in ways to avoid confirming instructors' potentially racialized and/or gendered beliefs of ability (Battey et al., accepted). Our study's first research question frames inquiry of ideological and institutional forces as concurrent influences on historically marginalized students' perceptions of introductory mathematics instruction as a racialized and gendered experience.

The research from which we drew to provide illustrative examples of the two framework dimensions focused on historically marginalized students' experiences in undergraduate mathematics classrooms. Our research extends this work in two ways. First, our work is one of the first studies to explore the experiences of Black students, Latin* students, and white women in the contexts of precalculus and calculus courses, which operate as racialized-gendered gatekeepers in higher education (Chen, 2013). Second, our analysis addresses the lack of systematic inquiry of racialized and gendered aspects of instruction, which impact historically marginalized students' experiences.

This systematic inquiry of instruction is designed to reveal *mechanisms of inequality* (Lewis & Diamond, 2015, p. 54), which are defined as daily enactments of seemingly neutral policies and procedures (e.g. school rules, curriculum and tracking) that (un)consciously perpetuate racialized and gendered inequities despite best intentions. Such mechanisms maintain discourses and organizational logics rooted in whiteness and patriarchy that preserve the racialized-gendered order of schools and classrooms.

With the present study's inquiry of introductory mathematics instruction as a function of whiteness and patriarchy in mathematics education, we adopt Lewis and Diamond (2015) concept of mechanisms of inequality as a lens for addressing the second research question. More specifically, we characterize mechanisms of inequality across historically marginalized students' perceptions of instruction to capture how instruction reinforces racialized-gendered inequities regardless of instructors' intentions.

Overall, our research extends prior work by identifying features of precalculus and calculus instruction that preserve the racialized-gendered status quo in mathematics education. In doing so, our work forms a bridge between discourses, organizational logics, and students' perceptions of everyday instructional events. The ideological and institutional dimensions in Table 1 guided our inquiry of how discourses and organizational logics shaped students' perceptions of instruction. Furthermore, our analysis sheds light on how racialized and gendered mechanisms linked to ideological and institutional influences were perceived as operating through instructional events.

This analysis, thus, aims to support instructors in developing consciousness for instructional behaviors that negatively impact historically marginalized students as well as adapting instruction to broaden classroom participation and student persistence in mathematics.

Methods

The present analysis comes from a larger, mixed-methods project of introductory mathematics instruction and its impacts on mathematical persistence from student and instructor perspectives. Our project's qualitative portion, which is the source for the present analysis, is a single-institution case study that employs self-report methods (e.g. interviews, student journals) to characterize supportive and marginalizing features of precalculus and calculus instruction. Here, we focus on identifying ideological and institutional factors that shape instructional mechanisms of inequality based on students' perceptions.

Given the lack of research on undergraduate calculus through an equity lens (Larsen et al.,2016), our analysis provides baseline, qualitative insights into racial and gendered oppression in instruction to inform larger studies with aims of generalizability, including the quantitative and multi-institutional portion of our project. As a qualitative analysis at a single institution, we acknowledge that our sample is not representative of historically marginalized students across different higher education institutions, so we cannot make generalizable claims about this population's instructional experiences or frequency of instructional mechanisms of inequality. Rather, our study design allows for a rich qualitative account of mechanisms in introductory mathematics instruction that contributes to theoretical explanations for its racialized and gendered functions.

Adopting an equity-oriented research approach (Gutiérrez, 2013), the present analysis foregrounds historically marginalized students' experiential knowledge as valid sources of insight to inform the disruption of racial and gendered oppression in instruction. Our analysis based on student interviews and journaling methods (further described below) allowed for a systematic approach to concretize racialized and gendered functions of instruction, particularly in terms of mechanisms of inequality rooted in oppressive discourses and organizational logics. We report elsewhere on other qualitative analyses of students' strategies for managing labor due to marginalization from instruction (Battey et al., accepted) and perceptions of supportive instructional practices (Leyva, Wolf, Amman & Battey, 2019). Without instructors' perspectives, we cannot make claims about their intent or beliefs related to instruction. However, elsewhere, we report on findings from instructor interviews that detail their level of consciousness regarding instructional practices' racialized and gendered impacts (McNeill, Marshall, & Leyva, in press).

Context and participants

The study took place at a large, public research university in the northeastern U.S. Precalculus and calculus courses at the university consist of: (i) a lecture, typically meeting in large halls with tiered seating, where content is introduced and (ii) a recitation, typically meeting in smaller classrooms, where instructors address students' questions about content and administer quizzes. Adjunct faculty typically teach the lecture meetings. Doctoral students and adjunct faculty typically teach the recitation meetings.

We conducted our study at this university for three reasons. First, the research team had existing relationships with the mathematics department through prior studies. This institutional partnership not only allowed access to students enrolled in introductory courses, but also provided a strong foundation for engaging research with an equity orientation to inform change in departmental practices. Second, given issues of racial and gendered underrepresentation in calculus, the university's strong racial and gender diversity ensured sufficient representation of historically marginalized students in these courses to complete the study. According to the university's

Table 2. Participant profiles.

Participant (pseudonym)	Race-gender identity	Course of enrollment	Semester interviewed	Intended major
Nadine	Black woman	Precalculus	Fall 2017	Engineering
Uzma	Black woman	Calculus I	Fall 2017	Unspecified STEM
Jasmine	Black woman	Calculus I	Spring 2018	Computer science
Regina	Black woman	Precalculus	Spring 2018	Biology
Dwayne	Black man	Calculus I	Fall 2017	Business
Parker	Black man	Precalculus	Fall 2017	Computer science
Quinton	Black man	Calculus I	Spring 2018	Not provided
Ife	Black man	Calculus I	Fall 2018	Not provided
Beatriz	Latina woman	Precalculus	Fall 2017	Biology
Victoria	Latina woman	Precalculus	Fall 2018	Computer science
Angelica	Latina woman	Precalculus	Spring 2018	Viola performance
Delma	Latina woman	Calculus I	Spring 2018	Engineering
Andres	Latino man	Calculus I	Fall 2017	Engineering
Leonardo	Latino man	Calculus I	Fall 2017	Ecology
Adrian	Latino man	Precalculus	Fall 2018	Astrophysics
Carlos	Latino man	Calculus I	Spring 2019	Engineering
Amy	white woman	Calculus I	Fall 2017	Forensic chemistry
Sarah	white woman	Calculus I	Fall 2017	Business/IT
Anne	white woman	Calculus I	Spring 2018	Not provided
Erica	white woman	Precalculus	Fall 2018	Marketing

institutional profile, the undergraduate population in fall 2017 was 46% white, 26% Asian, 14% Latin*, 9% Black, and 5% multiracial or some other race. In terms of sex, students were 52% female and 48% male. Third, with concerns about equitable outcomes for STEM persistence related to undervaluing instruction in research universities (Espinosa, 2011; Seymour & Hewitt, 1997), the university allowed for exploring mathematics instruction and equity-related implications for historically marginalized students in a research-intensive context.

The research team recruited participants during fall 2017 and spring 2018 by sending an e-mail to all students enrolled in precalculus and calculus courses, inviting Black students, Latin* students, and white women to participate. The e-mail informed students that they would be hired and paid hourly as research assistants in a study about different ways that students across race-gender intersections perceive instruction in introductory mathematics. Students were also informed that, as research assistants, they would keep a journal of brief notes about noteworthy instructional events in their mathematics classrooms and complete an individual interview to assist the research team with analyzing the nature of events. Study participation was for one semester, inclusive of journaling and the interview. Over 800 students expressed interest in the study.

Table 2 presents profiles for the 20 participants in our analysis, including their pseudonyms, race-gender identities, courses of enrollment, semesters when interviewed, and intended majors. All participants were first- or second-year students at the time of data collection. Participants completed a survey to provide information about their race, gender[3], course section, and any additional information they wanted to share. The first four students across five intersections of underrepresented racial and gender identities (Black woman, Black man, Latina woman, Latino man, and white woman) were selected to participate. Such sampling across race-gender groups allowed for attending to variation in the analysis at and across intersectional identities.

[3]The survey item collecting information about students' gender was inclusive of cis-gender, transgender, and gender nonconforming identities. For deeper within-group comparison, all recruited students self-identified as either cis-gendered women or cis-gendered men. There was limited expressed interest for study participation from students who hold transgender and gender nonconforming identities across racial categories.

Data collection

Event journaling

The first stage of data collection was *event journaling*, an adaptation of diary methodology from psychological research that involves participants documenting daily instances of oppression (Swim, Hyers, Cohen, & Ferguson, 2001; Swim, Hyers, Cohen, Fitzgerald, &Bylsma,2003). We extended this methodology by accounting for instances, particularly in instruction, that participants perceived as disrupting or perpetuating racism and sexism.

The present analysis is related to participants' journaling of uncomfortable or discouraging instructional events for them or others. Discouraging events could be explicit or implicit, including things *not* said or done. Events could be student-instructor interactions, instructor comments to the whole class, and peer interactions. Participants were provided a guiding prompt (Appendix A) that included these details about events' potential nature and instructions for how to document them.The prompt asked participants to take notes about event details (time, location, involved individuals, and actions and/or comments). Participants submitted events through an online form after class, including a description of the event and reflection on why they journaled it.

Event journaling as a diary methodology offers three advantages outlined in Swim et al. (2003) These advantages extend prior work on historically marginalized students' experiences in undergraduate mathematics classrooms largely based on interviews after a significant time-delay between everyday incidents and reporting. First, the event journals preserved details about instructional events for more textured accounts of their marginalizing or discouraging nature. Second, event journaling generated a robust collection of mundane and patterned instructional moments as opposed to solely standout moments in participants' memories. Third, journals tracked participants' immediate emotional and behavioral reactions to instructional events. Our collection of event journals provided a vivid account of everyday instances from instruction and participant responses to them, which allowed us to more concretely elucidate their connections to discourses and organizational logics that shape their racialized and/or gendered nature. Thus, event journaling contributed to systematic inquiry of precalculus and calculus instruction that would otherwise be limited by recency bias and participant recall.

Development of stimulus events for interviews

We developed two interview protocols centered on stimulus events derived from journaled entries submitted each semester. The number of entries varied widely by participant (e.g. one participant submitted 40 entries, other participants submitted none[4]). To ensure that journaled events were meaningful to participants' experiences, we did not require a certain number of entries to be completed. The team collected 85 journaled entries of discouraging or marginalizing events from fall 2017 and spring 2018. Interviews centered around 4–5 stimulus events (Appendix B) that varied by nature, likelihood to cause discomfort or discouragement, and individuals involved (e.g. entire class, instructor-student). Due to the limited number of journaled entries in fall 2017, the team purposefully selected four original entries for the fall interview protocol, which included events with an instructor: (i) confusing two women, (ii) accusing a student of not owning a calculator, (iii) not reviewing a student's requested problem, and (iv) advising an entire class to drop down a course level or not take Calculus 2 if they cannot complete a problem quickly.

For spring 2018, the team grouped journal entries by shared qualitative features of discouragement or marginalization (e.g. instructor ignoring a student response, instructor laughing at a student's contribution). The team developed a spring interview protocol centered around five stimulus events that represented these groupings. Some stimulus events were composites of

[4]Participants were compensated for each submission of a journaled event. On average, journaling a single event took 15 minutes, so participants were paid a quarter of their hourly compensation rate for each entry.

journaled entries in a grouping; other stimulus events were based on a single entry about a dimension of discouragement or marginalization that was not captured in other stimulus events. Spring interview events included an instructor: (i) ignoring a student's contribution, (ii) dismissing a student's request for clarification, (iii) cutting off a student who acknowledged a mistake on the board in order to justify it, (iv) laughing at an entire class and individual student for struggling with an "easy problem," and (v) cold calling on a student to answer a question[5]. Interviews completed in fall 2018 and spring 2019 used the protocol from the previous spring semester.

When creating stimulus events for interviews, the team edited journal entries' event descriptions to increase clarity while preserving student phrasing whenever possible. The team removed language about student reactions to events from spring entries since original entries were used for fall interviews. These edits allowed for participants to experience events in different ways while honoring the journaling participants' identification of events as discouraging or marginalizing. The team also redacted any mention of race for all events and gender for spring events[6], which allowed for exploring if participants' initial perceptions changed when they were later provided with details about race and gender.

Such development and use of stimulus events enabled participants to draw on personal experiences in undergraduate precalculus and calculus classrooms to support the team with identifying racialized and gendered mechanisms of instruction. By using sets of stimulus events across the interviews that varied in terms of what was happening, who was involved, frequency of occurrence, and the role of race and gender, the team created space in interviews for participants to elaborate on different contextual aspects of classroom instruction that would make the events racialized and/or gendered.

Interviews

The interviews were audiotaped, semi-structured, and lasted between 60–90 minutes. Ten participants (two per race-gender intersection) were interviewed each semester[7]. Our team involved in data collection and analysis includes four faculty members, four doctoral students, one graduate research assistant, and two undergraduate research assistants who were not study participants. Our team includes one Black woman, one Latina woman, four Latino men, three white women, and two white men. This paper's authors, who were also involved in data collection and analysis, self-identify as Latino men, a Latina woman, and white men. All participants, including those who did not submit journaling entries, were interviewed using stimulus events for the corresponding semester. To the extent possible, the team matched the race and/or gender of the 1–2 interviewers and participants as an attempt to create space where participants can feel comfortable discussing issues of race and gender. However, we recognize that comfort with engaging these topics is not guaranteed with the presence of someone else whi shares a racial and/or gender identity.

Participants were asked three sets of questions for each stimulus event: (i) what they saw happening and how frequently similar events occurred in classrooms, (ii) if they or others would feel discouraged or marginalized as well as their reasoning, and (iii) if and how their perceptions would differ depending on the instructors' and students' race and/or gender. Participants who submitted a journaling entry used as a stimulus event were asked for any additional perspectives about their experience beyond what they had already shared. Interview questions shed light on

[5]The stimulus event that involved cold calling on a student was not addressed in some participants' interviews due to time constraints, so we did not include it in the present analysis.

[6]The team inadvertently left pronouns signaling instructors' and students' gender identities in fall events. Despite this, we asked participants if their event perceptions changed if the gender identities were different.

[7]Five participants (Ife, Victoria, Adrian, Carlos, and Erica) were interviewed after spring 2018 to fill in gaps for planned recruitment across race-gender intersections in fall 2017 and spring 2018.

variation in and across race-gender groups about the perceived nature, frequency, and impact of stimulus events. Further, these interview prompts allowed for exploring how participants' perceptions of different stimulus events across these dimensions related to discourses and organizational logics.

Data analysis

Conceptual model

The central phenomenon characterized through our data analysis is the racialized and gendered nature of undergraduate precalculus and calculus instruction. Figure 1 presents a conceptual model of relations between different aspects of the data analysis process for detailing this phenomenon.

Participants' perceptions of instructional events reported as discouraging or marginalizing (Figure 1c) are the study's main units of analysis. These perceptions were generated during interviews through participant responses to prompts about the racialized and gendered nature of stimulus events of instruction (Figure 1a).

As described earlier, discourses and organizational logics are ideological and institutional influences, respectively, that characterize the functions of whiteness and patriarchy in mathematics education (Table 1). Thus, these broader influences (Figure 1b) impact the quality of undergraduate precalculus and calculus instruction that historically marginalized students may perceive as racialized and gendered, which is reflected in participants' interview responses. The bottom pair of arrows in Figure 1 depicts how these broad influences come together with our stimulus event prompts to generate student perceptions of precalculus and calculus instruction (Figure 1c).

The conceptual model's top arrow represents analysis of interview data of student perceptions to identify racialized and gendered mechanisms of inequality (Figure 1d), which are introduced and discussed in the findings. Our data analysis was centered on a coding scheme framed by ideological and institutional dimensions of the two frameworks discussed earlier (Battey& Leyva, 2016; Leyva, in press). Thus, our analysis characterized the study's central phenomenon by elucidating instructional mechanisms of inequality, including their connections to discourses and organizational logics.

Coding

A pair of research team members inductively coded the transcribed interviews using an open and axial coding scheme (Strauss & Corbin, 1998). To the extent possible, one member of each coding pair matched the interviewed participant's race and/or gender. First, we used open codes to flag instances when race- and gender-specific indicators of discourses and organizational logics were raised to describe how instructional events are marginalizing or discouraging. Recall that discourses and organizational logics are characteristic elements of the ideological and institutional dimensions of the study's analytical frameworks (see Table 1). These open codes, therefore, served to address our first research question about ideological and institutional influences that shaped participants' perceptions of instruction. Then, we used axial codes to address our second research question. Axial codes flagged instructional mechanisms of inequality in participants' responses associated with discourses or organizational logics.

As an illustrative example of applying this coding scheme, we present how two interview excerpts were coded. The excerpts are responses from Jasmine, a Black woman in computer science and taking calculus, about what she saw happening in the *dismissed student* event with an instructor chuckling and disregarding a student's question:

> With STEM disciplines, there's a lot of ego involved of 'You should be able to get it' … Either you get it or you don't type of scenario. It's like they're [instructors are] not as willing to take the time to sit down and

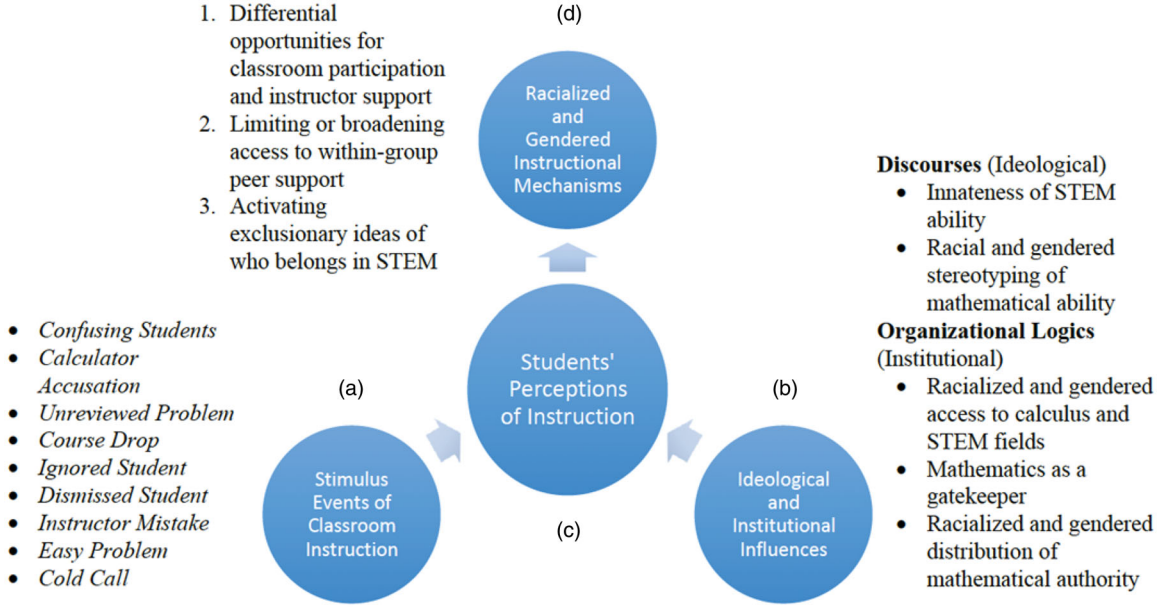

Figure 1. Model for detailing marginalizing features of precalculus and calculus instruction.

> explain every concept because they can't. There's a lot of material to go through. But it's not as welcoming in that sense. The teaching aspect.
>
> Yeah. I can't really imagine a female teacher laughing and repeatedly telling a student 'no' like that. But maybe it did happen. I'm not sure. But it seems like a male type of situation … It's like with technical disciplines, 'Yeah, you should know. Didn't you learn this in high school?' etc. Or like 'Why are you here?' Just a battling of knowledge base or just trying to devalue another person's knowledge base, whether intentional or not. I feel like that's a natural thing for males to do, unfortunately.

For these excerpts, we applied open codes for ideological discourses that *STEM ability is innate* and *masculine*. We also applied an axial code to flag the mechanism of *receiving limited support from instructors*. To make explicit the connection between the open and axial codes in this example, the discourse that STEM ability is innate shapes Jasmine's perception of instructor impatience with struggling students, which results in the mechanism of students having limited access to instructor support. Further, the discourse of STEM ability as a masculine trait influenced Jasmine's perception of this instructional mechanism as gendered, especially if the instructor in the stimulus event was a man.

After coding, the team synthesized codes to form broad categories of influences and instructional mechanisms of inequality raised across student perceptions of instruction. The two excerpts from Jasmine's interview presented above, for instance, were housed in the analytical category of *gendered stereotyping* as an ideological influence and *limiting instructor support* as an instructional mechanism. These categories, which are later used to organize the presentation of the findings, capture variation within and across race-gender intersections in how participants perceived racialized and gendered functions of undergraduate precalculus and calculus instruction.

Positionality

Team members built on each other's varied social backgrounds, educational experiences, and expertise in mathematics education as well as issues of racial and gender equity. In doing so, we approached the analysis with a collective positionality that addresses "dangers seen, unseen, and unforeseen in conducting research" (Milner, 2007, p. 388). A seen danger was avoiding a critical examination of the white, patriarchal functions of instruction. We addressed this danger through constant recognition of instruction as a function of systemic influences as well as awareness of our respective areas of privilege and oppression that may bias our analysis.

The team also recognized the unseen danger of not attending to how differences in our experiences as raced and gendered individuals impact data collection and analysis. We addressed this danger by ensuring, to the extent possible, that interviews and coding were completed in pairs that included team members who did and did not self-identify with a participant's race and/or gender. Such pairs allowed for the presence of multiple perspectives to inform following up on interview responses and developing analytical claims from coding. The team member who did not self-identify similarly was more readily able to bracket their lived realities from those of participants while still approaching the research with a lens of criticality. The team member who did similarly identify, while having an insider perspective beneficial to understanding race- and gender-related issues, more consciously engaged in bracketing their experiences apart from those of participants in approaching interviews and data analysis procedures.

Finally, the team attended to the unforeseeable danger of generating findings that position introductory mathematics course instruction as a uniform experience among historically marginalized students. Our sampling of participants across race-gender groups addressed this danger to capture variation in student perceptions within and across these groups, yielding a more complex understanding of instructional marginalization.

Findings

We organize the findings in two sections, each focusing on either an ideological or institutional influence that shaped participants' perceptions of instruction. The first section presents findings specific to racial and gendered stereotyping (an ideological influence related to discourses), which was invoked to describe how events reflected a mechanism of *creating differential opportunities for classroom participation and instructor support*. The second section presents findings specific to issues of racial and gender representation in introductory mathematics and STEM fields (an institutional influence related to organizational logics). Participants raised classroom representation in association with the mechanism of *limiting within-group (same-race, same-gender) peer support*, a form of support perceived as mitigating discouragement and marginalization. Representation in STEM fields was raised in association with a different instructional mechanism of *activating racialized and gendered ideas of who belongs in STEM*.

Aligned with the study's goal of completing a systematic analysis of student perceptions of instruction, the findings are based on participants' interview responses to the *same* sets of stimulus events used in either the fall or spring semester[8]. This allowed for characterizing variation in how influences related to discourses and organizational logics shaped perceptions of racialized and gendered mechanisms for the same events.

Each section begins with an overview of the ideological or institutional influence and its related mechanism(s), including the frequency to which they were raised across race-gender intersections. Two tables are included that account for the frequency that each influence and related mechanism(s) were invoked in interview responses per event. Then, participant responses are presented for events with higher frequencies of the reported influence and mechanism to capture variation in event perceptions within and across race-gender intersections. Each section concludes with a cross-case analysis of event responses to highlight how discourses or organizational logics shaped perceptions of racialized and gendered instructional mechanisms of inequality.

Stereotyping influence on classroom participation and instructor support

The ideological influence of racial and gendered stereotyping was raised among 16 of the 20 participants. Stereotypes were reported 24 times across participants and events. Over half of these instances ($n = 14$) associated stereotypes with the mechanism of creating differential opportunities for participation and support. Eleven of the 14 instances referenced racial stereotypes with the mechanism, including four that invoked both racial and gendered stereotypes. Table 3 and Table 4 present frequencies that stereotyping and this mechanism were raised. Frequencies are expressed in *n(m)* notation, with *n* representing the frequency that stereotyping was reported and *m* representing the frequency of these reports that raised the related mechanism.

For example, the entry *6(5)* for the *ignored student* event in Table 4 represents that five of the six reports involving racial stereotyping also raised how such stereotyping was related to an instructional mechanism of creating differential opportunities for participation and support. One example of these five instances, which is further discussed in this section, is Angelica's (Latina woman) perception of how racial stereotypes that Black and Latin* students are rude and troublemakers give rise to the mechanism of instructors limiting classroom participation among these students. Of instances that raised *both* racial and gendered stereotypes (fifth row entries in both tables), only one instance invoked a stereotype about a racial-gender group without raising the related mechanism.

[8]Elsewhere, we completed an analysis of the 85 total entries from event journaling to characterize discouraging and racialized features of undergraduate precalculus and calculus instruction (Amman, Battey, & Berninzon, 2020).

Table 3. Frequency of stereotyping influence and participation/support mechanism - fall events.

	Stimulus events				
Stereotype	Confusing students	Calculator accusation	Unreviewed problem	Course drop	Total
Racial only	1(1)	7(0)	0(0)	1(0)	9(1)
Gendered only	0(0)	0(0)	1(1)	0(0)	1(1)
Racial and gendered	1(1)	0(0)	1(1)	1(0)	3(2)
Total	2(2)	7(0)	2(2)	2(0)	13(4)

Table 4. Frequency of stereotyping influence and participation/support mechanism – spring events.

	Stimulus events				
Stereotype	Ignored student	Dismissed student	Instructor mistake	Easy problem	Total
Racial only	6(5)	0(0)	0(0)	1(1)	7(6)
Gendered only	0(0)	2(2)	0(0)	0(0)	2(2)
Racial and gendered	0(0)	1(1)	0(0)	1(1)	2(2)
Total	6(5)	3(3)	0(0)	2(2)	11(10)

The stereotyping-influenced instructional mechanism of creating differential opportunities for classroom participation and instructor support was largely raised in response to stimulus events that featured some form of student participation, such as asking a question (e.g.*unreviewed problem*) and seeking clarification or support (e.g. *ignored student*, *dismissed student*). Findings for this instructional mechanism are presented in two sections: one about racial stereotyping and one about gendered stereotyping. Despite this organization, we note instances that acknowledge the simultaneous influences of racial and gendered stereotyping. We conclude with a cross-case analysis of event responses across both sections to highlight the ideological influence of discourses in participants' perceptions of the stereotype-related mechanism.

Racial stereotyping

Three Black men (Dwayne, Parker, and Quinton), one Black woman (Regina), two Latina women (Angelica, Delma), and one Latino man (Adrian) associated the mechanism of limiting participation and support with racial stereotyping. Stereotypes included: Black and Latin* students behave rudely and cause trouble, Black students do not make an effort or care about education, and Black and Latin* students lack intelligence and mathematical potential. The mechanism was raised most frequently in response to the *ignored student* event, involving an instructor who twice ignored a student's raised hand at the front of the classroom. We now look across responses to this event that address how racial stereotyping can impact participation and support.

Black and Latin* students behave rudely and cause trouble. Angelica (Latina woman) and Regina (Black woman) acknowledged how stereotyping that Black and Latin* students behave rudely and are troublemakers produces differential opportunities for instructor recognition and support. To illustrate, Angelica, who journaled the *ignored student* event, described how this type of event happens almost every other week in her precalculus lectures to Black and Latin* students, "At least from what I've seen in my class, [the] professor's less inclined to try to include students of color in classes … If they have questions, he's not really willing to go out of the way to answer them." Angelica perceived such dynamics reflecting the potential influence of stereotypes about Black and Latin* students as rude and troublemakers that give rise to racialized exclusion.

> In general, there's more pressure for students of color to be more academically successful and absorb as much as they can from lectures and not really ask professors questions … Some will try to put more effort to seem as if they're doing work … And I guess professors tend to think, 'I've had students of color before who have done such and such that have been rude to me, so I'm just going to assume

> that everyone who's of that race is going to act that way.' So it's more of a pressure to try to not fit that stereotype, even though it shouldn't exist in the first place. Because not every student is like that and there are plenty of other troublemaker students, that aren't even of one sort of particular race.

This event response captures the pressure of academic success that Black and Latin* students experience, including their adoption of behaviors to ensure being perceived as making an effort and departing from negative stereotypes. Angelica, however, argues how instructors may appeal to racial stereotypes of behavior that cause them to ignore such efforts to be perceived as academically successful through classroom participation.

Further, Angelica referred to her precalculus instructor's pattern of racialized treatment of students to qualify her perception that the *ignored student* event reduces the comfort of asking questions among Black and Latin* students, including her.

> The professor is generally more rude towards African American students and sometimes Hispanic students … I can sense that they're [African American and Hispanic students] uncomfortable to ask questions … There were even other Hispanic students [that] have had the same issues, just a bit less frequently. I'm Hispanic myself, so it makes me less inclined to want to ask questions.

Angelica's response illustrates how racial stereotyping of Black and Latin* students' behavior, as an ideological influence, shapes perceptions of instructional moments like the *ignored student* event to create racialized opportunities for participation and support.

Black students do not try or care about education. Black participants argued how racial stereotypes about effort and caring about education shape differential opportunities to be called on (Dwayne) and receive support (Quinton, Regina). Quinton recalled experiencing something similar to the *ignored student* event in high school.

> Interviewer: Have you seen this going back to high school much?
>
> Quinton: Yeah, a little bit in high school. I have noticed that sometimes. I
>
> feel like definitely as a Black student … Sometimes, I did feel like
>
> teachers kind of, sometimes they would ignore me in a way like that. I felt like there was a perceived image … Like 'Am I really here for an education?' or something like that, which is ridiculous.
>
> Interviewer: Okay. It sounds like some of this might be aligning with a broader
>
> stereotype about maybe Black kids not caring about education, or
>
> not taking it seriously?
>
> Quinton: Yeah, I feel like they look at it as not taking it seriously. Don't get
>
> me wrong, there are students of every color that go to that school
>
> and they're not taking [sic] what they need to do … But I feel like,
>
> when you look at it, definitely race does play a part in it.

In this interview exchange, Quinton confirmed viewing racial stereotypes of Black students not caring about education shaping teachers' racialized assumptions about his academic investment, which led to being ignored like the student in the stimulus event.

Further, Quinton observed similar instances of students' ignored questions in his calculus recitation, which was "something that [he] feel[s] would more likely happen" to Black students due to racial stereotyping. Below Quinton remarks on how an ongoing experience of something like the *ignored student* event would cause discomfort that his calculus instructor was appealing to racial stereotypes like his high school teachers did.

> Interviewer: Going back to what you were saying earlier, that … everyone would feel uncomfortable in this situation, but some students might feel more uncomfortable. Is part of the reason you might feel more uncomfortable because it might align with that stereotype?

Quinton: It possibly could be. Also, I mean even if you want to go after the classroom [sic], it's a little more, 'Well what's going on? Why did you ignore me?' So it's more you feel uncomfortable even one-on-one personally.

Interviewer: So it sounds like you have to wonder in that moment if it's about this stereotype?

Quinton: Yeah. In some ways, you feel that way… Especially if it's a continuing thing, then yeah. Especially if it's happened twice, then, yeah. Something is definitely up with that.

Interviewer: So maybe if the professor missed you the first time…

Quinton: If they miss you the first time, they miss you the first time. If they missed you a whole second time…

Interviewer: Then you start to wonder?

Quinton: …then they're straight up ignoring you, yeah.

This excerpt captures how Quinton would "feel some type of way"[9] as a Black student if his calculus instructor ignored him multiple times, similar to his feelings of uncertainty about racial stereotypes causing high school teachers to ignore him. Quinton's perception of the *ignored student* event is illustrative of how stereotypes about Black students' lack of academic investment can produce an instructional mechanism of racialized support opportunities in introductory mathematics, leaving Black students wrestling with uncertainty about instructor disregard being rooted in stereotypes.

Black and Latin* students lack intelligence or mathematical ability. Participants' event responses recognized how racial stereotypes about intellect (Angelica) and mathematical ability (Adrian, Parker) can shape differential opportunities for participation and support through instruction. Adrian (Latino man) reasoned that the instructor in the *ignored student* event was potentially appealing to racial stereotypes about Black students' lack of academic or mathematical potential to meaningfully contribute, especially if such behavior was recurring with a Black student.

Interviewer: Say that the student in this case were an African American student, as opposed to a white student who was raising their hand and being ignored, would you interpret those situations differently or would you notice them differently?

Adrian: Yeah, I would sort of take notice of that more. If anything, that'd probably be more to what I was thinking before. If there was [sic] details of their race, where right now when I read this, since there's no details, I'm like, 'Maybe this is a bit of racism.' But if there was a definite race, that probably would've fed more into what I was thinking before, either in a strong direction or a weaker direction.

Interviewer: Mm-hmm (affirmative). So say that this were an African American male student… What do you think would be going on in this case? Why do you think that student would be being ignored?

Adrian: Depending on what the teacher or professor believes, like stereotype-wise. He could just really think that the student has nothing, no impact, nothing impactful to say that's worth his time, and everyone else's time. That's what I would think.

Adrian's perception of the *ignored student* event alludes to how the instructor's disregard for a Black student is possibly racialized and rooted in stereotypical beliefs about Black students' lack of academic or mathematical ability. This impact of racial stereotypes is further captured in Adrian's perspective that the instructional event is "probably a lot more stereotypical" if it

[9]In Black discourse, "feeling some type of way" is a phrase that can refer to having negative emotions (e.g. being offended, upset) or finding oneself emotionally conflicted or confused (see examples used in Nadal, Erazo, Schulman, Han, & Deutsch, 2017 and West, 2015). The context in which Quinton raises this phrase, particularly the potentially racialized nature of an instructor repeatedly ignoring him that he cannot confirm, arguably points more to him experiencing confusion or uncertainty.

involved a white instructor and Black student, with the latter "being targeted" as opposed to being unintentionally overlooked by the instructor.

Adrian, furthermore, reflected on the discouragement he would feel, particularly about "want[ing] to raise [his] hand anymore," if he was the student in the *ignored student* event. In light of the potential impact of racial stereotypes, Adrian described the additional effort that he would make to confirm the logic behind why the instructor ignored him, "I'd probably try to contact him or her after class, or maybe I'd shift a bit to the right or left… Another thing I could do is ask someone else around me if they could ask the question." Adrian's discouragement and extra effort in confirming the reasoning for an instructor's disregard can be likened to Angelica's discomfort and Quinton's uncertainty about being similarly ignored for racialized reasons. Adrian's response illustrates how racial stereotypes of mathematical potential shape marginalization that Black and Latin* students may experience, including limited opportunities for instructor support and acknowledgment. In addition, Black and Latin* students are taxed with the burden of managing uncertainty about racialized logics behind such forms of instructor neglect (see Battey et al., accepted).

Gendered stereotyping

Women participants across racial groups most frequently invoked gendered stereotyping, particularly that women are less able than men in mathematics (Delma, Sarah) and STEM broadly (Anne, Jasmine). Such stereotyping was viewed as shaping the mechanism of creating gendered opportunities for participation and support across four events (*confusing students*, *dismissed student*, *unreviewed problem*, and *easy problem*), but most frequently raised for the *dismissed student* event.

In response to the *unreviewed problem* event, featuring an instructor not going over a type of problem that a student asked to be reviewed, Sarah (white woman) argued how women are likely to feel discomfort due to stereotypes that disassociate them with ability and knowledge in mathematics. Sarah perceived such stereotyping as discouraging women's participation, including her own if she observed this happening to a woman.

> Interviewer: Would you perceive this event as being uncomfortable for any other students in the math class?
>
> Sarah: I feel they… it might affect them a lot more. Because if some of them have questions, it might stop them from raising their hand to ask their questions, especially if they want to ask another question on something they had already gone over, and just something they didn't understand still. It might stop people from wanting to ask questions and actually figure out the things they weren't sure of.
>
> Interviewer: Is there a specific student population you're thinking of when you say that?
>
> Sarah: It could be anyone who typically isn't involved in this. So it could be the female population or any minorities… Because if he had told this girl, 'Okay, I'm not going to answer your question, we're going to move on to another question. I'm going to answer this guy's question.' 'Oh, if he doesn't answer her question, why would he answer my question?' I might feel unwilling to raise my hand again and ask a question, especially if I was that girl. In the future, I probably wouldn't ask any more questions.

Sarah further clarified how this gendered discouragement that she might experience is rooted in that women are stereotypically positioned as a "group that's typically not associated with the field of math and knowing math." This event response shows how gendered stereotyping of mathematical ability created double standards between women and men for whose questions get addressed. Sarah's response about any role of race or gender in the event further captures such gendered biases shaping instructional decisions, "Maybe he [the instructor] thought, 'Okay, it doesn't matter. Everyone else understands it… Just because this one girl has another question doesn't mean I have to do it for the rest of the class." Thus, Sarah's perspective illustrates how

gendered stereotyping of ability can bring women to experience moments like the *unreviewed problem* event as having limited opportunities for instructor support in introductory mathematics.

Similarly, Jasmine (Black woman) raised gendered stereotyping of STEM ability in her perception of the *dismissed student* event, which features an instructor laughing at and dismissing a student's question. She observed this type of event "quite frequently" in high school and undergraduate mathematics. Jasmine reasoned that the instructor's behavior is a function of ego linked to the discourse that STEM ability is innate, "With STEM disciplines, there's a lot of ego involved of 'You should be able to get it' … Either you get it or you don't type of scenario." Such notions of innate ability have the power to build one's ego, which Jasmine saw in instructor impatience with struggling students that made instruction less welcoming. Jasmine stated, "They're [instructors are] not as willing to take the time to sit down and explain every concept because they can't. There's a lot of material to go through. But it's not as welcoming in that sense. The teaching aspect."

Jasmine further argued that such behavioral embrace of ego like in the *dismissed student* event is coded with masculinity, or associated with men's form of participation.

> Interviewer: Would the gender of the teacher … change your interpretation of this event?
>
> Jasmine: Yeah. I can't really imagine a female teacher laughing and repeatedly telling a student 'no' like that. But maybe it did happen. I'm not sure. But it seems like a male type of situation.
>
> Interviewer: Why is that? Why does it seem like a male situation? I think you talked about the ego thing. Would that be it or is there something else there?
>
> Jasmine: It's like with technical disciplines, 'Yeah, you should know. Didn't you learn this in high school?' etc. Or like 'Why are you here?' Just a battling of knowledge base or just trying to devalue another person's knowledge base, whether intentional or not. I feel like that's a natural thing for males to do, unfortunately.

This gender-specific reading of the *dismissed student* event depicts how Jasmine renders the instructor's jockeying of STEM knowledge as a masculine form of classroom behavior. Jasmine's response highlights how gendered stereotyping of STEM ability grants men more space to embrace their privileged status in the classroom, which can discourage women's participation. Like Sarah, Jasmine viewed such gendered dynamics as causing her to feel "very uncomfortable" and "very embarrassed to ask further questions" as the student in the event. Thus, Jasmine's event response illustrates how stereotyping of STEM ability as inherently masculine can shape women's perceptions of instructor disregard as gendered, consequently hindering their classroom participation.

Cross-case analysis: discourses in perceptions of stereotyped-influenced instruction

This section highlights how stereotyping, which is rooted in discourses of whiteness and patriarchy in mathematics education, shapes participants' perceptions of instructional events. Discourses, including mathematical ability as a racial and gendered hierarchy (Leyva, 2016; Leyva & Alley, in press; Martin, 2009) and innate (Battey & Leyva, 2016), give rise to racial and gendered stereotyping through instruction. Quinton's and Adrian's perceptions of the *ignored student* event pointed to how racial stereotyping, particularly about Black and Latin* students' lack of academic and mathematical potential, can contribute to instructor disregard for these students. Similarly, Jasmine invoked stereotyping of STEM ability as innate and masculine in her perception of the instructor's dismissiveness in the *dismissed student* event as a function of gendered ego.

The impact of discourses on opportunities for mathematical participation, as theorized in Wagner et al. (2012), is reflected in how participants viewed stereotypes as fueling the racialized and gendered instructional mechanism of limiting opportunities for classroom participation and instructor support. Angelica's response to the *ignored student* event raised racial stereotyping of Black and Latin* students' rude, trouble-making behavior to rationalize how these students are

Table 5. Frequency of representation influence and instructional mechanisms - fall events.

Site of representation	Stimulus events				Total
	Confusing students	Calculator accusation	Unreviewed problem	Course drop	
Mathematics classroom	3(1)	2(1)	1(0)	2(2)	8(4)
STEM fields	2(1)	0(0)	3(1)	5(4)	10(6)
Total	5(2)	2(1)	4(1)	7(6)	18(10)

Table 6. Frequency of representation influence and instructional mechanisms – spring events.

Site of representation	Stimulus events				Total
	Ignored student	Dismissed student	Instructor mistake	Easy problem	
Mathematics classrooms	2(1)	2(2)	1(0)	0(0)	5(3)
STEM fields	1(0)	1(0)	1(1)	0(0)	3(1)
Total	3(1)	3(2)	2(1)	0(0)	8(4)

more vulnerable to having their contributions overlooked, which may produce discomfort with classroom participation echoed in Adrian's event response. Gendered stereotyping of women's inferior mathematical ability shaped Sarah's perception of how double standards for determining whose questions get taken seriously during instruction may be at play in the *unreviewed problem* event, which would discourage her from seeking support if she observed something similar happening to another women in class. Thus, participants' event perceptions point to an instructional mechanism of inequality related to participation and support, which was conceived as a function of racial and gendered stereotyping rooted in discourses of mathematical ability.

Representation in introductory mathematics classrooms and STEM fields

Racial and gendered underrepresentation in introductory mathematics classrooms or STEM fields was raised among 12 participants. Recall that issues of representation are functions of organizational logics that create racialized and gendered access to advanced mathematics and STEM majors. There were 26 total instances when representation was invoked, most frequently in response to the *course drop* event. Fourteen of these 26 instances were associated with one of two instructional mechanisms: (i) limiting access to within-group peer support and (ii) activating exclusionary ideas of who belongs in STEM. Tables 5 and 6, using the same *n(m)* notation as the previous tables, present frequencies for raising issues of representation and these instructional mechanisms

Both instructional mechanisms were also raised most frequently in responses to the *course drop* event, with all instances of raising representation for this event except one invoking either mechanism. There were seven instances that associated classroom representation with the mechanism of within-group peer support, which participants found important for managing and defusing negativity in instruction. Another seven instances raised representation in STEM with the mechanism of activating exclusionary ideas of who belongs in these fields, often prompting reconsideration of STEM pursuits.

Below we present findings for the institutional influence of representation in two sections – one focused on the mechanism of within-group peer support and another on the mechanism of belongingness in STEM fields. We conclude by looking across both sections to highlight how participants' perceptions revealed how instruction perpetuates racialized and gendered organizational logics in mathematics education. Mechanisms of within-group peer support and STEM belongingness depict the oppressive impact of precalculus and calculus instruction explained away by colorblind, gender-neutral logics.

Within-group peer support

Five participants across race-gender groups (Anne, Beatriz, Leonardo, Nadine, and Quinton) raised racial and gendered underrepresentation in introductory mathematics across their perceptions of an instructional mechanism related to within-group peer support. This mechanism of inequality was reported most frequently for the *course drop* and *dismissed student* events. The following sections present different ways that within-group peer support (or lack thereof), a function of classroom representation, was perceived to influence students' management of oppression in instruction.

Mitigating academic pressure. Black and Latin* participants (Beatriz, Nadine, and Quinton) raised how racial underrepresentation in classrooms limited access to same-race peer support for managing potentially racialized aspects of instruction. The *course drop* event features an instructor's whole-class comment that students should drop down a course level or not take Calculus 2 if they cannot complete a problem quickly. Nadine (Black woman) discussed how such frequently-heard messages create pressure for the few Black or Latin* students in classrooms to prove their academic ability. Below is Nadine's response to the fact that a Latino man submitted the *course drop* event:

> Interviewer: So, a Hispanic male reported this event. How do you react to that? How does that affect your interpretation of what's happening?
>
> Nadine: I feel like minorities already … It's already difficult to get through certain classes because you don't have the support system. It's maybe just you and a couple of other kids. You're a little bit more isolated. You have a lot more pressure to succeed because it's not typical for … other people of your race to succeed … For me, it's the whole 'People said I couldn't and, therefore, I'm going to and I'm going to do it well.' When things like this happen, I'm like, 'Am I on the level the professor said? If I'm not, what am I doing wrong?' And, again, you're adding stress to your class and you're making it a lot more difficult for the student to focus on learning.

Nadine perceived racial underrepresentation in introductory mathematics classrooms as isolating Black and Latin* students, which limits their access to support from other racially underrepresented peers of color. Further, Nadine acknowledged how such isolation leaves underrepresented students, including herself, on their own to manage the pressure of academically proving themselves after hearing instructor messages like in the *course drop* event. She described how support networks with racially underrepresented peers of color can help with overcoming such pressures, "You put pressure on things, it can go one of two ways. The student can crack or the student gets through it. More often than not, if you don't have a support system there, you crack." Nadine, thus, perceives peer support among racially underrepresented students, largely missing for Black and Latin* students in introductory mathematics, as mitigating pressure from instructors' remarks that, as described later, gatekeep access to more advanced mathematics.

Processing emotional responses. Quinton (Black man) similarly argued how racial underrepresentation in introductory mathematics leaves Black students on their own with managing emotional responses to negative instructional events, including uncertainty about potentially racialized behavior. He described how the *dismissed student* event, featuring an instructor laughing at and dismissing a

student's question, would make him feel frustrated, disrespected, and unsafe to ask questions, especially as one of the only Black students in the classroom. Quinton remarked, "You want to eat the things, but I feel, in that scenario, I would explode… I would stop the class until she [the instructor] told me the answer. Because, at that moment, I would probably feel disrespected."

Racial underrepresentation in classrooms make such negative emotions challenging for Quinton to process without the support of fellow Black classmates. Quinton reflected on possible differences between how a white and Black student would experience the *dismissed student* event in introductory mathematics at the university:

> Quinton: I feel like it would definitely be perceived a different way from a white person's perspective and a Black student's perspective. As a Black student, you're definitely keeping in the back of your mind… that the reason they ignored me was that I am Black.
>
> Interviewer: Right. Right.
>
> […]
>
> Quinton: You don't always want to pull it out, they say, 'Pull out the race card.' You want to sometimes evaluate the situation and see. But in a situation like that, that's definitely… It's glaring.
>
> Interviewer: But it sounds like regardless of whether you have someone to process that with in the moment, you're going to be wondering or it's going to be playing in your head, "Was that about race?"
>
> Quinton: Of course. In having that be more represented and having someone else to be in there to say, 'Was that about race?'… I'm part of a fraternity and I have fraternity brothers. If there's something in this scenario that I can clarify, you know, 'Do you think this was that?' Because I think that it's important to react the correct way because you never know where people are coming from.

Quinton perceives racial underrepresentation in introductory mathematics as removing opportunities to process and check in about instructional moments being racially charged. Like Nadine, Quinton argued that support from other racially underrepresented students of color, such as that from his fraternity brothers, mitigates negativity that Black and Latin* students experience through instruction (e.g. uncertainty about racial undertones).

Fostering within-group solidarity. Anne (white woman) and Leonardo (Latino man) acknowledged how having classmates of the same underrepresented race or gender fosters within-group solidarity to mitigate oppression from instruction. Analogous to Nadine's assertion that support from racially underrepresented peers mitigates racialized forms of academic pressure due to instructional moments like the *course drop* event, Anne argued how stronger representation of women in introductory mathematics can mitigate pressure to prove their ability following potentially gendered instructional events. For instance, Anne described how the *dismissed student* event "happen[s] so many times" and creates pressure of "hav[ing] so much more to prove and so much more to show" among women. She argues how disrupting women's lack of representation in her calculus class could foster within-group gender solidarity that defuses pressure and divisive competition from moments like the *dismissed student* event.

> I think that if there was [sic] more women in the class, especially in my lecture, because our lecturer is female… I think it would just be easier. The vibe would be different. I think that there would definitely be more of a view towards everybody helping each other and working together and less like the way it is now where it's everybody fends for themselves and it's a struggle to be the best… There would definitely be a different type of class setting.

Anne asserts that having a woman as her calculus instructor was insufficient in defusing gendered tensions that moments like the *dismissed student* event fuel in her class due to gendered underrepresentation. Exclusionary norms of individualism and competition in mathematics went unchallenged through the instructor's actions, thus perpetuating tensions among underrepresented students to outperform rather than support each other. Thus, Anne asserts that increased presence of women underrepresented

in introductory mathematics can broaden opportunities to mobilize solidarity that mitigates this gendered impact of instruction.

Such within-group solidarity, from a more race-based perspective, is reflected in Leonardo's (Latino man) response to the *calculator accusation* event, featuring an instructor accusing a student of not owning a calculator that a campus program provides students from low-income backgrounds. Leonardo described that, as the student in the event, he would think that the instructor was appealing to the racial stereotype that Latin* people are criminals, which may cause same-race classmates to defend the accused student as a form of within-group solidarity. In particular, Leonardo asserted that same-race peers "might be a little bit more defensive toward it because they might also assume the teacher is being racist." Analogous to Anne's gender-specific perspective, Leonardo viewed stronger same-race representation as increasing within-group solidarity among racially underrepresented students to resist potentially racialized instructional moments.

Activating exclusionary ideas of who belongs in STEM

Another instructional mechanism of inequality raised across participants' perceptions of instructional events, particularly related to racial and gendered underrepresentation in STEM fields, was activating exclusionary ideas about who belongs in STEM. This mechanism was reported seven times (Tables 5 and 6), particularly by five women across racial groups (Amy, Jasmine, Sarah, Uzma, and Victoria). The mechanism was most commonly engaged in response to the *course drop* event, which was described as a type of situation that happens regularly in introductory mathematics. As an illustrative example, Victoria (Latina woman) discussed how, in light of women's underrepresentation in STEM, the instructor's remark in the *course drop* event may cause women who take longer to complete mathematical work to perceive this event as confirming that women do not belong in fields that require advanced mathematics, including computer science. The following two sections present different ways that participants raised the instructional mechanism of activating exclusionary ideas about belonging in STEM: one about mathematics as a gatekeeper and another about distribution of mathematical authority.

Mathematics as a gatekeeper. Amy (white woman) and Uzma (Black woman) perceived instructional events as activating exclusionary ideas about belonging in STEM while addressing the role of mathematics as a gatekeeper of STEM majors and careers. Uzma described feeling discomfort if she had experienced the *course drop* event, especially since Black women must cope with being underrepresented in STEM fields on top of navigating racialized *and* gendered messages of not belonging in these fields.

> Interviewer: If this happened in a classroom that you were in, would this be something that you would describe as uncomfortable for you?
>
> Uzma: Yeah, definitely. Because math is a basis for a lot of other STEM fields… But that's often the feeling, and also just for instance, in terms of how higher education is set up. If you don't pass your math courses, you can't move on to your other STEM courses.
>
> Interviewer: Do you think that this would be something that would make everyone in the class uncomfortable, or specific groups of people?
>
> Uzma: I think it could have the potential to make everybody uncomfortable, but I think it's varying degrees… Female groups would definitely feel this more than male groups, but I do think that male minorities would feel this more than white female minorities, and that's the same for minority females [who] would feel it more than everybody else.
>
> Interviewer: Why is that?
>
> Uzma: I think it comes from just having two things stacked against you that, one, you're a female, and two, you're a minority. This idea that not only do you not belong because you're a woman, you also don't

> belong because you're a minority, and you're not a model minority. You're minority minority. I think it would definitely be seen as 'Well, then shit, then I guess I'm not supposed to be here' type of thing.

Uzma perceived the *course drop* event as especially uncomfortable and disheartening for Black and Latin* women because it activates both racialized and gendered ideas of who belongs in STEM. She also noted the role of mathematics as a gatekeeper in STEM higher education, which makes the stakes for mathematical persistence higher for Black and Latin* women underrepresented in fields requiring advanced mathematics classes.

Uzma underscores this gatekeeping influence in describing the increased pressure that she feels, as a Black woman, when instructional moments similar to the *course drop* event frequently happen in large, introductory STEM courses like calculus, "It just comes from that idea that your math ability is directly correlated with your intelligence … It's how other STEM fields relate to math … If you're not good at math, then you're not good at all the other fields." Thus, Uzma argues that equating mathematical ability with STEM potential, coupled with the instructor's comment in the *course drop* event about re-thinking future mathematics coursework, creates undue pressure for students from underrepresented communities in STEM. Even though the instructor's comment in the event was directed to the entire class, Uzma's event response depicts how it can uniquely activate exclusionary ideas about who belongs in STEM for underrepresented groups in these fields, which perpetuates the gatekeeping function of mathematics by causing them to question their ability and STEM pursuits that require more advanced mathematics.

Distribution of mathematical authority. Jasmine (Black woman) and Sarah (white woman) perceived instructional events as activating exclusionary ideas about who belongs in STEM while alluding to racialized and gendered distribution of mathematical authority. Jasmine, for example, invoked such distribution when describing the exclusion that historically marginalized students may experience with the *instructor mistake* event. This event features a student correcting an instructor's mistake and getting interrupted with the instructor's attempt to justify it. Jasmine perceived "a lot of power moves" in the event, especially if the student was Black, Latin*, or a woman due to racialized-gendered ideas of who belongs in mathematics and STEM in general.

> Math is supposed to be a white, Asian, male type area. And anyone who doesn't fall into that, [the correction] just seems a challenge or 'You're encroaching on space that doesn't belong to you or that society says doesn't belong to you.' And that's very disheartening in the sense that women are already not going into STEM fields for these exact reasons. … Women and minority STEM applicants just don't feel supported in that sense.

Jasmine's response captures how students may experience the instructor's behavior in the event as activating racialized and gendered ideas of who belongs and holds authority in mathematics. As a result, these ideas can shape racialized and gendered double standards for who can correct a mathematics instructor, which Jasmine perceived as not welcoming underrepresented students' contributions and discouraging their STEM pursuits.

To further illustrate such discouragement, Jasmine recalled eliciting a similar reaction from her calculus instructor after volunteering a correction that made her feel she was "overstepping [her] bounds" and "not even included in the conversation." This incident stopped Jasmine from offering corrections in her next calculus course and was demoralizing to her as a Black woman in a computer science major requiring multiple semesters of mathematics, "It becomes very disheartening when you feel like, 'If I correct someone or if I offer another suggestion, they're going to feel threatened or they're going to feel like 'Why are you even trying to come at me?'". Jasmine's event response, therefore, illustrates how racial and gendered underrepresentation in STEM can shape historically marginalized students' perceptions of instructor dismissiveness as activating exclusionary ideas of who belongs in STEM. This instructional mechanism of inequality reinforces ideas of a racialized-gendered distribution of mathematical authority in the classroom, which deters underrepresented students' classroom participation and STEM persistence.

Cross-case analysis: organizational logics shaping perceptions of instruction linked to issues of representation

We now look across the previous two sections about the institutional influence of representation to highlight how students' perceptions reflect instruction as a function of racialized and gendered organizational logics in mathematics education. The first section focused on issues of representation at the classroom level that, as described earlier, are explained away by organizational logics rooted in colorblindness and gender neutrality, which shape seemingly neutral instructional practices that have oppressive impacts on historically marginalized students.

To illustrate, although neither race nor gender were explicitly invoked in the *course drop* and *dismissed student* events, participants across race-gender intersections reported experiencing them in racialized and gendered ways due to their sense of being underrepresented in classrooms. Nadine and Anne, for example, appealed to the representation influence in describing how these events produced pressure of proving themselves academically as one of the only Black students and women, respectively. Thus, organizational logics in mathematics education founded on discourses of innate ability (Battey & Leyva, 2016) and norms of individualism (Borum & Walker, 2012) justified instructional practices represented in the events that have marginalizing impacts. Furthermore, the first section captured how classroom representation impacts access to within-group peer support for managing racialized and gendered impacts of instruction. This mechanism of limited within-group support makes it challenging for underrepresented students to overcome racialized and gendered instructional moments, perpetuating organizational logics of individualism and mathematics as a gatekeeper.

The second section highlights the institutional influence of STEM fields' racial and gendered underrepresentation on historically marginalized students' perceptions of instructional events. With calculus coursework required for various STEM programs of study (Larsen et al., 2016), organizational logics that contribute to racial and gendered underrepresentation in introductory mathematics arguably reproduce inequitable access to STEM fields. These logics, including mathematics as a gatekeeper and inequitable distribution of mathematical authority, were raised in participants' perceptions of instructional events as activating exclusionary ideas of who belongs in STEM.

This instructional mechanism, fueled by organizational logics rooted in colorblind and gender-neutral discourses (e.g. innateness of mathematical ability), justify seemingly neutral instructional events that were perceived to have racialized and gendered impacts on classroom participation and STEM persistence. Uzma's response to the *course drop* event, for example, illustrates how this instructional mechanism maintained the organizational logic of mathematics as a gatekeeper by way of bringing Black and Latin* women to question their potential and pursuits of STEM majors that require multiple semesters of mathematics. Thus, the mechanism of STEM belongingness perpetuates organizational logics in mathematics education through seemingly neutral yet discouraging instruction that reinforces racial-gendered underrepresentation in STEM.

Discussion

This section first elaborates on the scholarly significance of the present study, including how it extends prior work and nuances thinking about issues of equity in undergraduate mathematics education. Then, we present three conclusions based on our interpretations of the findings. Lastly, we raise implications for research and practice.

Scholarly significance

Our findings extend prior research on equity issues in mathematics education research in two ways. First, there is little equity-oriented research about precalculus and calculus instruction,

which is an important void to address since these courses serve as gatekeepers to mathematical persistence and STEM fields (Chen, 2013; Larsen et al., 2016). Prior research has provided strong evidence that negative experiences in introductory mathematics classrooms lead historically marginalized students, including Black students (e.g. Jett, 2013), Latin* students (e.g. Leyva, 2016), and white women (e.g. Ellis et al., 2016), to switch out of the calculus sequence and/or reconsider their STEM pursuits. Yet, there is little research on *how* and *why* instruction in these spaces can be discouraging and marginalizing, which our study contributes to the literature.

Second, research involving historically marginalized students in post-secondary mathematics education has generally asked participants to discuss their aggregate experiences in undergraduate courses after months or years since they occurred (e.g. Leyva, 2016; McGee & Martin, 2011). Our methodology complements this valuable work by investigating students' responses to specific instructional events based on daily journaling, thus offering a more fine-grained and systematic approach to exploring how marginalization transpires through introductory mathematics course instruction.

Interpretations of the findings

We present our interpretations of the findings as three general conclusions. Each conclusion addresses a different dimension of the conceptual model (Figure 1) used to characterize the study's central phenomenon: the racialized and gendered nature of undergraduate precalculus and calculus instruction.

Marginalizing instruction may not be explicitly racialized or gendered

Our first conclusion is that instructors do not need to explicitly mention race, gender, or language interpreted as coding race and gender for an instructional event to be perceived as racialized and/or gendered. This conclusion is specific to the conceptual model's dimension of stimulus events from classroom instruction (Figure 1a). None of the events were explicitly racialized or explicitly gendered. Nonetheless, as Tables 3–6 document, they were perceived as racialized and gendered. With race and gender left unnamed in instruction, oppressive discourses of mathematical ability shaped uncertainty about racialized and gendered stereotypes at play. Organizational logics linked to racial and gendered underrepresentation had a similarly negative impact, leaving historically marginalized students without same-race, same-gender peer support to process these instructional events and with questions about belonging in mathematical spaces.

To illustrate, despite the lack of mention race or gender, *course drop* was the instructional event that participants most frequently perceived as potentially racialized and/or gendered. The event involved an instructor relaying a whole-class message about dropping down a course level if students could not a problem quickly without any explicit mention of race or gender. The institutional influence of representation in mathematics classrooms and STEM fields shaped perceptions of the event as marginalizing. Thus, even if racialized and gendered messaging was not explicit or overt, instructional events discussed in this paper were perceived as potentially reaffirming stereotypes of ability and perpetuating exclusionary ideas about who belongs in STEM. These findings point to the importance of instruction that explicitly names whiteness and patriarchy in mathematics education (Adiredja, 2019; Joseph, Haynes, & Cobb, 2016), as further discussed below in implications for practice. Such naming disrupts colorblind, gender-neutral framing of mathematics instruction that leave historically marginalized students grappling with the possibilities of racism and/or sexism at play.

Instruction cannot be decontextualized of sociohistorical realities

Following this line of thinking, the second conclusion is that instructors' behaviors and comments cannot be decontextualized from sociohistorical realities in which they occur. This conclusion relates to the conceptual model's dimension of ideological and institutional influences (Figure 1b). Coupled with instructional behaviors, these influences shape historically marginalized students' perceptions of instruction as racialized and gendered. Discourses and organizational logics provide one account of sociohistorical realities that influence these perceptions of instruction. While such perceptions are subjective and informed by prior mathematics experiences, sociohistorical realities of discourses and organizational logics accounted for in participants' perceptions are *not* purely subjective. We maintain that it is a fact that there are racial and gendered discourses about mathematical ability as well as what types of behaviors and learning opportunities are acceptable in mathematical spaces (Gholson & Martin, 2019; Leyva, 2016, in press).

Discourses of mathematical ability as innate and a racial-gendered hierarchy are ideological influences that shape stereotyping, which many participants perceived to be operating in instructional events that featured students being ignored or dismissed. To illustrate, the *dismissed student* event, which featured an instructor laughing at a student's question and repeatedly not providing an answer, was one of the events more frequently perceived as racialized or gendered due to stereotypes. Jasmine (Black woman), for example, imagined the event to more likely involve a man as the instructor and be rooted in gendered stereotyping of STEM ability. She perceived such stereotyping to create more space for men to embrace their gendered privilege and be less patient with women's bids for support. Thus, the sociohistorical reality of discourses about mathematics as a masculine domain (Leyva, 2017; Mendick, 2006) shaped Jasmine's gendered perception of the *dismissed student* event despite not being explicitly gendered.

We also assert that it is a fact that Black students, Latin* students, and white women are underrepresented in introductory mathematics and STEM fields due at least in part to organizational logics, including inequitable tracking policies and instruction based on a racialized-gendered distribution of mathematical authority (Larnell, 2017; Leyva, in press). Participants raised such issues of representation as institutional influences to qualify how instructional events, although not explicitly racialized or gendered, may cause students across underrepresented race-gender intersections to experience pressure about proving their academic ability, uncertainty about racial or gendered undertones, and reconsideration of their mathematical persistence or STEM pursuits. We further draw your attention to findings for the *dismissed student* event, which illustrate this point as the event was also commonly perceived as racialized or gendered due to issues of representation in introductory mathematics classrooms. Quinton (Black man), for example, reflected on how the lack of Black peers in the classroom limited his access to within-group peer support in processing emotions of uncertainty and disrespect due to the instructor's potentially racialized dismissal of a student's question. Therefore, the sociohistorical reality of Black students' underrepresentation in mathematical spaces (Berry, 2008; Martin, 2009) influenced Quinton's racialized experience of the *dismissed student* event despite the instructor's dismissal not being explicitly racialized.

Instructional mechanisms perpetuate whiteness and patriarchy

Our final conclusion is that participants' perceptions of instructional events as racialized and gendered (Figure 1c), following our analysis, reveal mechanisms of inequality in undergraduate precalculus and calculus instruction (Figure 1d) that perpetuate whiteness and patriarchy in mathematics education. These instructional mechanisms included: (i) creating differential opportunities for classroom participation and instructor support, (ii) limiting within-group peer support, and (iii) activating exclusionary ideas of who belongs in STEM. Our findings about these mechanisms, including their connections to discourses and organizational logics in mathematics

education, provide concrete evidence for contouring the study's central phenomenon – the racialized-gendered nature of undergraduate precalculus and calculus instruction.

In interpreting the findings, historically marginalized students' perceptions of instructional events pointed to mechanisms of inequality through seemingly neutral behaviors and comments that reinforced whiteness and patriarchy. To illustrate, the *ignored student* event, which involved a student's raised hand being ignored twice during a lesson, was the event that was most frequently perceived as racialized. Several participants reflected on the event being rooted in racial stereotyping that shaped a mechanism of limiting Black and Latin* students' opportunities for classroom participation and instructor support. Black and Latin* students appealed to this mechanism in reflecting on their discomfort (Angelica), uncertainty (Quinton), and discouragement (Adrian) tied to the possibility that instructors' disregard was a function of racial stereotyping. Thus, this instructional mechanism of inequality preserves whiteness and antiblackness in mathematics education that structure racialized inequities of participation and access to content (Battey& Leyva, 2016; Martin, 2019).

Since our analysis was based solely on student interviews, we do not have access to instructors' intentions related to classroom events that revealed instructional mechanisms of inequality. However, we draw on Lewis and Diamond (2015) to assert that the *impact* rather than the intent of instructors' actions should be the focus to advance understandings of equitable instructional practices in introductory mathematics. Our study accomplishes that by elucidating three racialized and gendered instructional mechanisms linked to white, patriarchal discourses and organizational logics, which shaped students' perceptions of instructional events as discouraging and marginalizing.

Implications for educational research and practice

The present study's insights and limitations inform implications for research in undergraduate mathematics education as well as instructional practice in undergraduate precalculus and calculus. Our small sample with four participants at each of the five race-gender intersections in our analysis limited the extent to which we could detail variation in how students in a race-gender group perceived and experienced. For example, while our findings capture how several instructional events were perceived as creating undue labor (e.g. uncertainty about instructors' intent, pressure to prove academic ability), our sample size limited our ability to characterize intersectionality in how members of race-gender groups varyingly experienced such oppression and coped with it. Thus, there is room for future studies with larger sample sizes to explore variation in students' perceptions of introductory mathematics instruction as a racialized-gendered experience as well as coping strategies within and across race-gender intersections.

In addition, our study was limited to capturing historically marginalized students' instructional experiences during a single semester of introductory mathematics. Longitudinal inquiry beyond introductory mathematics can shed light on instructional practices and other institutional influences that disrupt white, patriarchal functions of mathematics education and contribute to STEM persistence. Our findings are also specific to the context of a large, public, and historically white research university. With student diversity and institutional commitments to instruction varying across higher education contexts, our claims about racialized and gendered functions of instruction are limited to our focal institution. Thus, this leaves room for research that explores variation in historically marginalized students' perceptions of introductory mathematics instruction across institutional spaces with varying demographics and commitments to classroom teaching (e.g. liberal arts colleges, minority-serving institutions).

For instructional practice implications, our findings and conclusions point to the need for precalculus and calculus instructors' consciousness of whiteness and patriarchy embedded in undergraduate mathematics education, including their influences on students' classroom experiences.

As our analysis shows, simply avoiding mention of race or gender is not sufficient to prevent the enactment of instructional practices that marginalize Black students, Latin* students, and white women. On the contrary, instructors who explicitly acknowledge racial and gendered inequities in mathematics education and design instruction to address them foster equitable learning opportunities.

For example, with greater awareness of how stereotyping shapes instructional mechanisms that create differential opportunities to participate in classrooms and receive instructor support, instructors can recognize such negative stereotypes and co-construct norms of classroom engagement with their students to avoid inadvertently perpetuating racial and gendered hierarchies of mathematical ability. Such norms may include the valuing of thinking over speed and accuracy as well as honoring questions as ways to advance the class's collective understanding rather than as indicators of individual deficits. Instructors' awareness of how organizational logics tied to inequities of representation influence historically marginalized students' perceptions of instruction can inform practices that build within-group peer connections. For instance, instructors can formalize study groups as part of introductory mathematics courses through which students, especially from underrepresented groups, can connect with same-race, same-gender peers in different course sections or more advanced mathematics courses. Such connections increase opportunities for within-group support and solidarity that participants perceived as critical in mitigating discouragement and marginalization from instructional events.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by the National Science Foundation under DUE-IUSE1711553& DUE-IUSE 1711712.

ORCID

Luis A. Leyva http://orcid.org/0000-0002-1704-0784
Daniel López http://orcid.org/0000-0002-6158-739X

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Appendix A

Event journaling prompt

As you attend your math class, please keep daily journals labeled with the *date*. Please also note whether the class was a *lecture* or *recitation*.

1. During class, jot a very brief note to document events during your class that may be uncomfortable for particular students. Include a *key phrase* describing what was said or done or overlooked, the *time* the event occurred (e.g. 2:05 pm), and *1–2 words describing what could make someone feel uncomfortable* about the event. Events to note might include those that:
2. Occur during the class that make you feel uncomfortable or out of place.
3. You suspect might be problematic. Perhaps these events make other students feel uncomfortable, or they just seem a bit "off."
4. You can imagine would bother other students in the class, even if you were not personally bothered by the event.
5. May be general comments made by the instructor or other students as well as interactions either between the instructor and other students or between students.
6. People do *not* say, do *not* do, or avoid saying/doing that make you or others uncomfortable.
7. After the event is over, briefly reflect on the event.
8. Try to relate the event to past experiences you have had, whether inside or outside of this classroom. Have you encountered similar events before? In other mathematics classrooms? What about in other undergraduate classrooms (e.g. STEM, social science, humanities)?
9. Does the event reflect a pattern of behavior within or around this classroom (e.g. office hours, interactions with other students)? Does the event represent a pattern of behavior you've observed across your experiences in mathematics?
10. Could the event that you noted potentially be offensive to other students? Would they be more likely to offend specific groups of students? How so?
11. How do you see race, gender, and/or any other identities (either that of the instructor or the student(s)) playing a role in the event? To what extent would the event have varied if the instructor's and/or student(s)' identities were different?

Appendix B

Stimulus events for interviews

Stimulus events for fall interviews

Confusing students

My recitation teacher was going over math problems related to our quiz that we were about to take and she asked if any of us had any questions. I raised my hand and so did a girl that was to my left about a seat back in space. She pointed my direction and called out "[Name A]". I looked back thinking she was trying to call on the girl behind me. The girl shook her head at me and indicated that the professor was referring to me. I looked back at the professor and let her know I wasn't [Name A]. I told her that my name is [Name B]. The professor looked over a couple of seats to my right and said that she had confused me with [Name A] that was a couple seats down because "we both have black hair" and "we both wear glasses". Then she continued to say for me to just go ahead and ask the question. In this incident I felt very uncomfortable. This situation had everyone looking at me and by the time I realized I was able to ask my question I didn't really want to anymore because it was a simple question that didn't need everyone's attention.

Calculator accusation

During a lecture, Professor [X] was making a demonstration of how students should mark their calculators for identification for the exams. She collected mine and used it as an example. My calculator had an XYZ tag on it because the XYZ program gave me the calculator. As the professor was doing the demonstration she said "this calculator is not yours". I told her that those were not initials and that EOF was a program that gave me the calculator. As a result, I was not able to concentrate on what she was saying anymore.

Unreviewed problem

I had just finished asking a question and the professor asked if anyone else had a question. This girl raised her hand and asked the professor to go over any question related to the domain of a function. The professor simply indicated that she had just finished going over a domain question so the professor didn't try another one as the girl had asked her to. The professor continued and asked if anyone else had any questions. As the professor asked that question out loud and began to take a new question, the girl next to me turned to a guy next to her and said "I want to do a different problem, I'm going to do a different problem" and continued on to do a different question on her own. The class didn't have many more questions after that one.

Course drop

During class the professor said something along the lines of, "If you do not know how to do these steps quickly you might want to consider dropping down to a lower class or consider not taking Calculus 2". As a student who wants to major in a STEM field it made me feel a bit uncomfortable because I did take a bit longer to do the steps. At the time of the event I thought to myself if I was good enough to go on to Calculus 2.

Stimulus events for spring interviews

Ignored student

The professor was going through a problem on the board and, in the middle of the problem, a student sitting toward the front of the classroom raised their hand to ask for clarification on a portion of the problem. After two minutes with their hand up, the student gave up on asking the question having been completely ignored. This also occurred 6 minutes prior, when the same student tried to ask a question.

Dismissed student

The professor was writing the solution to a problem involving radicals. A student asked whether or not a number without a radical and one with a radical could be added to simplify the answer. Instead of explaining why this was not possible, the professor chuckled and repeatedly told the student "no". The student repeatedly asked why and did not receive an answer. Eventually, the student apologized for asking the question in the first place and the professor moved on.

Instructor mistake

Our professor was finishing a problem, but when recopying the step in the problem, the professor wrote a number incorrectly. A classmate and I raised our hands to bring it up, but it took almost a minute or so before being acknowledged. As I was explaining what was wrong, the professor cut me off saying "Yeah, I know" and gave a number of excuses to avoid seeming incorrect. The professor has been corrected before and would admit being

wrong and thanked the students for catching the mistake, but did not do so when corrected by me.

Easy problem

During recitation, we received part of our first exam back. The professor kept saying "This is easy" and "You guys should've got this" while laughing at us. One student came in late to class and asked about a problem from the exam that had just been reviewed. The professor said, "I just went over this, but this was such an easy problem everyone got wrong." Additionally, I approached the professor after class about the problems I got wrong hoping to maybe get extra points. Instead, the professor told me "This is so wrong, I don't know how you got credit for this" and just laughed.

Cold call

During lecture, our professor occasionally calls on random students to answer questions. While we were learning about trig functions, the professor abruptly called on a student and asked a question. The student was put directly on the spot and kept guessing the answer while the professor did not acknowledge the student's responses. Eventually, the professor said that the student should already comprehend what was being taught. The professor continued smiling and stating how the student should know the answer.