Whiteness-at-work in Mathematics Department Initiatives to Ameliorate Racialized Gatekeeping in Calculus

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Racialized gatekeeping in calculus courses is a national, systemic concern. However, research on equitable calculus instruction has focused on classroom-level changes, providing limited guidance for department-level reforms necessary to implement change in large calculus programs. To extend such work, we present a case study of a mathematics department at a large university engaged in improving its calculus program to better serve Black and Latin students. Informed by critical whiteness studies, we explore how whiteness was maintained amidst this equity-oriented initiative. Findings exhibit disciplinary-specific forms of whiteness that stymied departmental reform. Implications are provided for equity-oriented, department-level change.*

Keywords: whiteness, mathematics faculty, calculus, testing

Study Purpose & Background

Across the nation, undergraduate calculus serves as a source of racialized attrition from STEM majors (Chen, 2013). In response, mathematics education research has increasingly explored racialized aspects of undergraduate mathematics to offer guidance for advancing equity through instruction (Larnell, 2016; Leyva et al., 2021). However, disciplinary and departmental factors can hinder the implementation of such antiracist instructional recommendations (Ching & Roberts, 2022). The prevalence of faculty's colorblind beliefs that mathematics is a neutral space (McNeill et al., 2022) can impede sociopolitical noticing in the classroom (Louie et al., 2021), making it difficult for instructors to enact equitable instruction. Furthermore, racially-conscious instructors can find their agency to implement instructional changes limited by the coordination of calculus courses across multiple sections. Prior research has explored department-level change efforts in coordinated calculus courses, but such interventions have largely focused on implementing generally supportive practices (e.g., incorporating active learning pedagogies; Williams et al., 2022). Such practices leave the racialization of undergraduate mathematics uninterrogated, including the role of calculus as a gatekeeper to STEM majors, and therefore fall short in improving course experiences among racially minoritized students (Leyva et al., 2022).

Higher education research shows that departmental changes are mediated by faculty's racial beliefs as well as historically white institutional structures and policies. During equity-oriented systemic change efforts, these manifestations of whiteness can contribute to internal contradictions that can cause interventions to fall short of their antiracist aims (Dowd & Bensimon, 2015). Critical analysis of race in such research has been reserved for student experiences, leaving little guidance about how to counteract whiteness in faculty politics. Such analyses are necessary in undergraduate mathematics where disciplinary values, which reflect the values of white, male elites who historically codified academic mathematics (McNeill & Jefferson, in press), also mediate departmental change. Systemic solutions to address racialized gatekeeping in calculus must anticipate and counter ideological forces of whiteness in both the discipline and educational structures to actualize equity-oriented aims. This requires understanding the functions of whiteness in disciplinary values and institutional structures.

This paper presents a case study of a mathematics department at Wesselman University

(pseudonym), an institution engaged in reforming its calculus program to better serve Black and Latin* students. Informed by critical whiteness studies, we assume that whiteness is omnipresent and explore its workings in this change initiative through the following research questions: (1) How is whiteness functioning in the mathematics department's initiatives to ameliorate racial inequities in calculus courses?; and (2) What role does mathematics, as a discipline, play in the reproduction and disruption of whiteness within calculus courses and the department?

Theoretical Perspectives on Whiteness

Whiteness is a set of ideologies that reinforce white supremacy, antiblackness, and systemic racism (Bonilla-Silva, 2006). For example, of particular relevance to the present analysis is the ideology of "quantity over quality" (Jones & Okun, 2001), which describes placing a high value on outputs, especially those counted or quantified. This ideology is prevalent in mathematics as a quantitative field, privileging abstract and generalizable approaches to produce expedient solutions over problem-solving approaches that attend to social context and purpose. Consequently, mathematical procedures are leveraged in situations like warfare with limited ethical consideration (Ernest, 2018) and, furthermore, dehumanize mathematics students by prioritizing the productivity of their labor over the learning experience (Ladson-Billings, 1997). Characteristics of whiteness such as these structure norms in undergraduate mathematics classes that reinforce racialized access to participation and recognition (Leyva et al., 2021).

We engage two theories of whiteness to guide our analysis. First, the theory of white institutional space (Moore, 2008) characterizes how organizations and institutions, such as law schools (the context in which the theory was developed), enact whiteness to maintain racial inequity. Moore characterized white institutional spaces as having four features:

> (1) Racist exclusion of people of color from elite law schools and positions of power in legal institutions, which results in the accumulation of white economic and political power, (2) The development of a white frame that organizes the logic of these institutions and normalizes white racial superiority, (3) The historical construction of a curricular model based on the thinking of white elites, and (4) The assertion of law as a neutral and impartial body of doctrine unconnected to power relations. (p. 27)

A white frame can be understood as a set of perspectives, shaped by ideologies of whiteness, that are used to make sense of everyday situations and shape individuals' inclinations to action.

Historically, whiteness has flexibly adapted to maintain dominance in a dynamic U.S. racial context (e.g. Bonilla-Silva, 2006). Whiteness-at-work (Yoon, 2012), the second guiding perspective for our analysis, characterizes these adaptations. Whiteness-at-work describes how individuals ascribe to ideologies that embody contradictions and paradoxes, thus creating the appearance of having progressive racial values while reinforcing racial oppression. For example, a white teacher expressing a desire to 'call out' colleagues on their racially- oppressive beliefs while simultaneously avoiding workplace conflict demonstrates whiteness-at-work (Yoon, 2012).

Together, whiteness-at-work and white institutional space complemented each other to guide our analysis of whiteness in the Wesselman mathematics department. Namely, we examined how whiteness-at-work among faculty gives rise to contradictions that impede equity-oriented reform and thus maintain workings of the mathematics department as a white institutional space. An illustrative example of whiteness-at-work maintaining a white institutional space in a mathematics department is a predominantly white faculty ensuring a short list of job candidates is racially diverse and then eliminating a Black candidate because her job talk used mathematics to interrogate racialized policing (McNeill & Jefferson, in press).

Methods

Research Context and Participants

Wesselman University is a large, elite, predominantly white, research-intensive university in the southern U.S. During the 2022-2023 academic year, the mathematics department had approximately 30 tenure-track faculty, 20 postdoctoral faculty, 10 senior lecturers, and 25 doctoral students. The demographics of the entire teaching staff were approximately 70% white and 85% male. During the same year, the domestic undergraduate population was roughly 40% white, 20% Asian American, 10% Black, 10% Latin*, 5% multiracial, and 5% unknown race.

In 2020, the department and university identified a need to improve the calculus program, particularly to ameliorate racial disparities in calculus grades and attrition from STEM majors. Before changes were initiated, weekly course meetings consisted of three lectures taught by the instructor (a graduate student, postdoc, or lecturer) in groups of 40 students, and a discussion taught by a graduate teaching assistant in groups of 20 students. All class meetings, including discussions, were led in a lecture-based format. Assessment structures included four midterm exams and a final exam. Exams took place in large lecture halls that held multiple sections of the course. Hats, backpacks, and other items were not allowed. Instructors were directed to "actively proctor" exams. Questions were not permitted. Students experienced exams as high-stress environments and frequently reported that they did not have enough time for the exam.

The research team (the three authors) began a collaboration with the Wesselman mathematics department in Spring 2021. Our partnership was structured in three phases: (1) Documenting Black and Latin* students' experiences in calculus; (2) Exploring instructor and stakeholder sensemaking about racial equity in calculus courses and related interventions, and (3) Facilitating professional development with calculus staff. The present analysis is based on data from the second phase, during which several interventions were being piloted. These included some implementation of active learning, the introduction of undergraduate course assistants who led small study groups outside of class, and replacing the fourth midterm with a "redemption test" that could replace a midterm grade. Indicators suggested that these interventions improved, but did not eliminate, racial disparities in grades. The mathematics department continued to function as a white institutional space despite these interventions. Corresponding to Moore's characteristics of white institutional spaces, this is demonstrated by: (1) A mathematics faculty that is approximately 70% white; (2) Shared departmental values that reflect whiteness, such as wanting to treat all students the same; (3) A curriculum supported by textbooks written almost entirely by white men; and (4) A shared perception of mathematics as socially-neutral.

Prior to the beginning of the Fall 2022 semester, instructors teaching calculus I courses were invited to participate in the study at an in-person meeting of calculus staff, and again through email. Faculty who were stakeholders in calculus reform efforts, such as the department chair, the coordinator for calculus courses, the director of undergraduate studies, and members of the "rethinking calculus" committee, were also invited to participate through email. All who expressed interest participated. In this report, we describe participants in aggregate to preserve anonymity given the unique departmental context. The 22 participants consisted of 11 calculus instructors (five lecturers and six doctoral students) and 13 stakeholders (seven tenure-track faculty members, five lecturers, and a postdoctoral scholar), with two participants serving in both instructor and stakeholder roles. Participants were majority white and men.

Data Collection & Researcher Positionality

Data consists of interviews with instructors and stakeholders as well as class observations and departmental artifacts. All interviews were semi-structured, audio recorded, and transcribed

verbatim. Interview questions solicited instructor and stakeholder perspectives on: (1) the role of race in students' experiences and instructors' decisionmaking; (2) traditions in and changes to the calculus program; and (3) participants' role and agency in the mathematics department.

Interviews averaged one hour in length, with stakeholders participating in one interview and instructors participating in four. While the topics discussed with instructors and stakeholders were similar, interviews with instructors were more oriented towards instructional sensemaking. For example, the third interview asked instructors to read excerpts from interviews with Black and Latin* students from the first phase of the study, and consider to what extent students in their course(s) might have similar experiences. One abbreviated excerpt is presented below.

> When I'm under [test] time pressure stress, I just start making stupid mistakes. But then when I do take my time, I don't finish my problems on time… When I just saw that [exam] grade, I was like, "Oh…that's really going to hurt my GPA."... That was what compelled me to drop the class... It was just a matter of weighing what was going to push me farther in life… I don't want to be another Black kid just growing up to be nothing. I feel like breaking those social norms or those social views of being Black, that just pushes me to be successful… And so me not doing well in calculus wasn't really an option, per se.

Interviews with stakeholders had a more expansive focus beyond the classroom and into the departmental context. For example, stakeholder participants explored connections between interview topics and their involvement with the calculus program (e.g., as a member of the "rethinking calculus" committee).

Secondary data sources included classroom observations and departmental artifacts. Each instructor was observed four times. Observations were documented with field notes and audio recordings. Departmental artifacts included course syllabi, instructional policy documents, and reports produced by department members that proposed or evaluated interventions.

Two authors collaborated with the mathematics department to build rapport with participants and enhance our understanding of the research context. The second author, a white woman, participated on a search committee. The first author, a white transgender person, taught a calculus course and served as an instructor participant in the present study. The first author conducted all data collection for which they were not a participant, allowing them to provide instructional feedback and raise topics from informal collegial conversation during interviews. The third author, a Latino man, provided an outside lens for analysis informed by his research expertise on equity issues in undergraduate mathematics education. Collectively, we were reflective about how our respective experiences of privilege and oppression shaped our perceptions of whiteness in mathematics. The team resisted deficit interpretations of participants' reflections while maintaining critical awareness that participants served as representatives of a discipline and institution that are historically entrenched in racism.

Data Analysis

Theoretical perspectives of whiteness-at-work and white institutional space guided data analysis that followed an open, axial, and selective coding scheme (Strauss & Corbin, 1998). We used three sets of open codes. One set of open codes captured white racial frames (Moore, 2008), such as paternalism and individualism (Jones & Okun, 2001), used in participants' sensemaking about race, change initiatives, and their role in the calculus reform. This set of open codes contributed to answering our first research question about how whiteness influenced reform initiatives. Another set of open codes flagged organizational tensions. These included collegial conflicts or lack of support, organizational barriers that impede change, and mixed messaging

from faculty leadership. The focus on organizational tensions highlights contradictions and paradoxes that exemplify whiteness-at-work (Yoon, 2012), also addressing our first research question. An additional set of open codes flagged instances where the mathematics discipline shaped participant sensemaking about racial equity and related change initiatives in calculus. This included using mathematical language, applying quantitative or formal logic, and appealing to mathematics epistemological values (e.g., abstraction, generalizability; McNeill & Jefferson, in press). This set of open codes supported our exploration of the second research question about how white frames and organizational actions are shaped by the mathematics discipline.

We used two sets of axial codes. One set flagged connections between white racial frames and organizational tensions to address our first research question about whiteness-at-work. Another flagged connections between white racial frames and mathematics, addressing our second research question about mathematical influences on departmental reform in calculus. Selective codes extracted contradictions that exemplify departmental whiteness-at-work.

Findings

For brevity, this report presents one form of whiteness, "quantity over quality," through two contradictions that exemplify whiteness-at-work in calculus reform. We use testing as a focal context to illustrate the maintenance of whiteness amidst equity-oriented reform.

The department privileged quantitative evaluations of student performance through testing over qualitative aspects of learning despite little inquiry into the validity of quantitative evaluation measures. Such valorizing of quantitative evaluations was based on the departmental beliefs that quantities provided a neutral measure of merit. Since evaluation structures were constructed to ensure some failure, this departmental practice functioned as a meritocratic mechanism for denying resources (e.g., access to more advanced courses) among those deemed unfit and therefore reproduced racialized gatekeeping in calculus.

Contradiction 1: Trying to Reduce DFW Rates While Maintaining Historical GPAs

Whiteness-at-work was evident in the department's effort to maintain the historical GPAs while expressing a desire to improve student success in calculus. As one stakeholder articulated,

> If we define success as getting… a C or higher… pretty reliably, 80% of students succeed in calculus. Then there's the 20% who aren't succeeding and we want to figure out why, so that we can propose solutions to help those students succeed. We don't expect everybody to succeed… but 20% seems like a high number.

Improving the proportion of students who receive a C or higher in the course would require that students receive higher grades on tests, given that test scores constituted 85% of a student's grade. Thus, maintaining historical GPAs conflicted with commitments to improving success rates.

Test design was a central context that contributed to whiteness-at-work, wherein whiteness in the form of "quantity over quality" framed the department's underemphasis on qualitative aspects of learning. The appropriateness of a test was determined primarily by the range of scores it produced, with less oversight given, for example, to the alignment of test questions with course learning goals. As one stakeholder shared,

> There were no TA meetings, there was no emphasis or monitoring, mentoring of first-time instructors. There were no discussions about where everybody was in the course… It was this idea that the principle of academic freedom meant that you could teach whatever you wanted, however you wanted, as long as the average of a test exam was X. And nobody really monitored... What was the validity of X? How do we get X? How do we design a test?

A focus on exam averages rather than content supported reductionist views of tests as either easy or hard. To produce tests that were the desired difficulty, instructors described constructing test questions from textbook problems beyond those assigned for homework. One instructor shared that "some problems… are super similar to the problem set, which will be more easier ones," and "If you go to every section… to the 60s and 70s, although those ones aren't [assigned], I do look at some of those to try to see about slightly harder ones to turn into a more harder exam problem." The same instructor described receiving feedback from students that "people wanted to see… more exam-type problems in class," suggesting that students perceived that class did not prepare them for the exams. Such test-design strategies reflected the sentiment that a stakeholder perceived as common on student evaluations: "assessments are harder or different than what is being taught in the class or what is being practiced on out-of-class assignments."

Adherence to historical averages was a central priority, despite the department's professed commitment to advancing equity and the qualitative misalignments between presented, practiced, and tested content. Following the first midterm, one instructor was advised to produce lower test scores on subsequent exams. In a later discussion with a stakeholder about implementing this advice, the impact on STEM persistence among Black students, who had received lower test averages as a group, was framed as a lesser concern than reproducing historical averages.

> *Instructor*: In terms of test writing for the next time… I'm imagining what the score distribution might have been if I had just made a harder test, and I'm imagining that [racial] gap between 83 and 70 moving to 75 and 62, or something like that… given that [Calculus I] is a prerequisite and a required class for so many students' majors, it feels like shifting the test average for Black students in my class down to a 62 potentially could have some real ramifications on their careers.
>
> *Stakeholder*: Given the fact that the Black students are getting lower averages than the white kids, then if you make your exam… harder… to lower your average, then you're going to put these kids in dangerous territory. On the other hand, I think that you probably don't want to be in a position where we are just starting tweaking with how we teach calculus in your course. I don't think it would be a problem if your course has an average 85 or whatever, but from the point of view of how things are currently set up in the math department that would spark a lot of probably unpleasant conversations. Right? You don't want to be there. It's not up to you to be tackling this problem right now.

Whiteness in the form of "quantity over quality" was visible in the department's adherence to historical GPAs. This prevented addressing testing structures that were an established source of STEM attrition among Black and Latin* students, thus reflecting whiteness-at-work in the contradictions between faculty's commitments to equity and the reproduction of DFW rates that the department wished to address.

Contradiction 2: Teaching and Learning Priorities Disincentivized by Evaluation Practices

Instructors and stakeholders expressed beliefs that students motivated by test scores would engage in rote learning. This was misaligned with desires for students to engage in collaborative mathematical sensemaking. The department's evaluation practices strongly emphasized scores. At the same time, reducing the percentage of students' grades that were determined by tests or redesigning tests to better incentivize desired forms of learning were not widely-considered interventions. Instead, instructors and stakeholders described a need for students to hone test-taking skills, in some cases advocating for more class time devoted to test-taking strategies. Whiteness in the form of "quantity over quality" can be seen in the department's loyalty to traditional quantitative assessment strategies, even when such assessments were at odds with

qualitative aspects of their teaching goals as well as Black and Latin* students' wellbeing.

When responding to the interview prompt about testing, GPAs, and racialized pressure (see "Methods" section), an instructor claimed that prioritizing test scores hindered student learning.

> *Instructor*: This always makes me cringe. It [the interview prompt] was just like "This is really going to hurt my GPA."
>
> *Interviewer*: What's cringey about that to you?
>
> *Instructor*: Oh, I guess it's the fixation on grades, just this shows that this is in many students' eyes, and maybe rationally... "It's my job here to be the good grade getter."
>
> *Interviewer*: You feel like it gets in the way of learning?
>
> *Instructor:* I think so.

Simultaneously, preparation for tests often included instructional messages like the following:

> You have to put your economics hat on when you take tests and do a cost-benefit analysis… Time is currency that you have, the good that you are going to get back is points. Don't invest too much of your currency into a not-valuable commodity.

In emphasizing test-taking strategies in these ways, the department explicitly directed students to focus on aspects of the course that were viewed as unproductive for learning.

The misalignment between learning goals and the emphasis on testing limited the efficacy of an intervention designed to better support Black and Latin* students. Structured study groups led by undergraduate course assistants were implemented to foster peer support and a sense of belonging, particularly for racially minoritized students. A report on the efficacy of the piloted course assistant program found it to be successful in achieving these goals. However, attendance waned because students did not perceive that attending study groups helped them with exams. Commenting on this pattern, the report stated, "We believe that it would be a dereliction of our duty as instructors to teach our students that the only calculus problems that are worth thinking about and doing are the ones that could appear on an exam." In response, the report suggested calculus staff should "step up our messaging to the students about the purpose of the [study group] tasks" rather than consider how assessment structures could better incentivize the socially-supportive study group learning. In this way, this intervention embodied a paradox: aiming to ameliorate racial disparities in grades by encouraging Black and Latin* students to engage in mathematical work that students perceived to not significantly influence their grade.

Discussion & Implications

Our analysis highlighted two contradictions depicting whiteness-at-work. Whiteness functioned through a focus on quantitative measurables (i.e., grades), and a de-emphasis of qualitative aspects of calculus teaching and learning. While interventions introduced did improve calculus courses and reduce racial disparities in grades, such improvements were incremental and preserved functions of the mathematics department as a white institutional space. Such incremental changes reflect how institutions of mathematics education appear to be progressive, and at the same time, reflect forms of self-correction that reproduce racism (Martin, 2019).

Critical analysis of local data is important to produce change within mathematics departments (Bressoud & Rasmussen, 2015; Felix et al., 2015). Although student evaluations, test scores, and overall GPAs can serve as such local data, faculty must approach these data with equity-mindedness (Dowd & Bensimon, 2015) to mitigate possibilities for white racial frames, such as values around quantitative evaluation, to drive reform efforts and, thus, stymie their equity-oriented goals. Institutions invested in department-level equity reform should consider ways to integrate support and accountability for faculty within mathematics departments to ensure that implemented interventions are aligned with broader equity goals.

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