A critical look at undergraduate mathematics classrooms: Detailing mathematics success as a gendered and racialized experience for Latin@ college engineering students

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Latin@s demonstrated an increase of nearly 75% in engineering degree completion over the last 15 years (National Science Foundation, 2015). However, Latin@s remain largely underrepresented across STEM disciplines with scholars calling for analyses of their undergraduate education experiences to improve retention (Cole & Espinoza, 2008; Crisp, Nora, & Taggart, 2009). With calculus as a gatekeeper into advanced STEM courses, undergraduate mathematics must be examined as a social experience for underrepresented populations including Latin@s. This report presents findings from a phenomenological study on mathematics success as a gendered and racialized experience among five undergraduate Latin@ engineering students at a large, predominantly white institution. In light of recent calls for equity considerations in undergraduate mathematics education (Adiredja, Alexander, & Andrews-Larson, 2015; Rasmussen & Wawro, under review), this report focuses on the Latin@ students' classroom experiences with implications for broadening Latin@s' and other underrepresented groups' access to high-quality, supportive learning in undergraduate mathematics.

Key words: Gender, Intersectionality, Latin@s, Race, Teaching

Introduction and Related Literature

Mathematics has been well documented as a gendered and racialized space for marginalized populations including women (Boaler, 2002; Mendick, 2006), African Americans (McGee & Martin, 2011; Stinson, 2008), and Latin@s[1] (Oppland-Cordell, 2014; Téllez, Moschkovich, & Civil, 2011). Issues of gender and race, however, have largely been studied separately in extant mathematics education research with minimal insight on how their intersections lead to varying forms of mathematics experience. For example, while such intersections have informed sampling of participants such as African American males across studies using a critical race theory lens, race was the primary focus of their analyses with considerations of how gender shaped participants' racialized mathematics experiences left implicit (Leyva, accepted).

Scholars, therefore, are calling for intersectional analyses that highlight variation of mathematics experience among historically marginalized groups at different intersections of their identities (Esmonde, Brodie, Dookie, & Takeuchi, 2009; Martin, 2009; Oppland-Cordell, 2014). Latin@s, in particular, have "seldom been asked for their perspectives on their classroom mathematics experiences" (Varley Gutiérrez, Willey, & Khisty, 2011, p. 27) to shed light on how they negotiate their multiple identities with their mathematics success.

In undergraduate mathematics education, Rasmussen & Wawro (under review) argued that considerations of such equity issues are the "next steps" in understanding how mathematics instruction can be more responsive to the cultural and linguistic diversity in undergraduate classrooms. Last year's Research in Undergraduate Mathematics Education

[1] Drawing on Gutiérrez (2013), the term Latin@ decenters the patriarchal nature of the Spanish language that traditionally groups Latin American women and men into a single descriptor (Latino) denoting only men. The @ symbol allows for gender inclusivity among Latin Americans compared to the either-or form (Latina/o) implying a gender binary.

(RUME) conference proceedings echoed the calls for intersectional considerations of mathematics experiences and identities. Namely, Adiredja, Alexander, and Andrews-Larson's (2015) theoretical report offered a conceptualization of equity for undergraduate mathematics education challenging researchers to pursue data analyses and reporting of findings with a critical awareness of the "intersectionality of identity."

Study Overview and Research Question

In response to this need of equity scholarship to inform more critical approaches in undergraduate mathematics education, this preliminary research report presents findings from a phenomenological study that used intersectionality from critical race theory (Solórzano & Yosso, 2002) and Latin@ critical race theory, or LatCrit, (Bernal, 2002) to characterize mathematics success among five undergraduate Latin@ engineering students at a large, predominantly white four-year institution. The study used a three-tiered analytical framework from prior work (Leyva, under review) to detail the institutional, interpersonal, and ideological dimensions of the Latin@ students' mathematics success.

For this report, these three dimensions are considered in relation to instruction and student learning in the undergraduate mathematics classroom context. This analysis particularly focuses on the extent to which these classroom situations were gendered and racialized experiences as well as how this shaped the Latin@ students' academic pursuits at the university. More explicitly, this report addresses the question, "In what ways did undergraduate mathematics classroom experiences afford or limit opportunities for mathematics success as Latin@ engineering students at the university?"

Theoretical Perspectives

Critical race theory (CRT) in education is a perspective that "foreground[s] and account[s] for the role of race and racism" (Solórzano & Yosso, 2002, p. 25) in efforts to disrupt racism and other intersecting systems of societal oppression (e.g., sexism, classism) in schools and classrooms. One of the CRT tenets in educational research is recognizing what Kimberle Crenshaw (1991) coined as *intersectionality* referring to the mutual constitution of oppression at intersections of race, class, gender, and other identities (Solórzano, 1998). As a "close cousin" to CRT, LatCrit examines intersectionality among Latin@s in relation to issues such as culture, immigration, and language that often go unaddressed under CRT (Bernal, 2002).

Phenomenology informed the study's methodology of collecting and critically examining multiple "texts of life" (Creswell, 2013) to detail the phenomenon of mathematics success among the five Latin@ engineering students at a large, predominantly white institution. Under the CRT perspective, these "texts of life" inform the analytical construction of Latin@ participants' *counter-stories* (Solórzano & Yosso, 2002), or personal narratives challenging racial discourses of mathematics ability among people of color including Latin@s. The study's coupling of CRT with LatCrit guided the analysis of intersectionality across Latin@ participants' counter-stories and classroom experiences in undergraduate mathematics.

Data Sources and Research Methodology

Study Participants

This study took place at a large state university in the northeastern United States during the 2014-2015 academic year. Less than 15% of the 2011-2012 graduating class was

Latin@. These Latin@ graduates earned only 10% of the university's conferred degrees in STEM areas.

The Latin@ participants were purposefully recruited based on criteria informed by scholarship on "successful" underrepresented students in STEM (Cole & Espinoza, 2008; McGee & Martin, 2011; Stinson, 2008). Five Latin@ students (2 women: Diana and Zoila; 3 men: Benito, Cristian, and Daniel) were recruited from the university chapter of the Society of Hispanic Professional Engineers (SHPE), a national organization aimed at empowering the Hispanic community in realizing its potential in engineering through STEM outreach and professional networking.

Data Collection

Four types of data were used: (i) mathematics autobiographies, (ii) field observations, (iii) semi-structured interviews, and (iv) a focus group. Informed by critical race methodology (Solórzano & Yosso, 2002), the autobiographies, interviews, and focus group were used for the analytical construction of Latin@ participants' counter-stories as students in undergraduate mathematics classrooms. Field observations in their mathematics classrooms as well as the engineering and mathematics departments provided situated insights to complement participants' reflections of their experiences. Insights from the study's interviews and focus group will be the focus of the analysis presented in this report.

Throughout the academic year, participants completed four 60-minute, semi-structured individual interviews. All interviews were audiotaped and transcribed verbatim. The interviews were opportunities for participants to share and explore what being Latin@ and mathematically successful meant to them across different contexts (e.g., classroom, home, SHPE meetings). Interview questions were structured in an open-ended manner allowing participants to describe varying levels of consciousness of their different identities across these contexts including the mathematics classroom (Bowleg, 2008).

In addition, participants completed a focus group structured around three stimulus narratives based on observations in their lectures and recitation/workshop sessions. These narratives related to ideas of students taking up classroom space, stereotypes of mathematics ability, and faculty-student relationships. Participants were probed on the extent to which they observed such dynamics in mathematics classrooms and whether or not they saw themselves in similar situations. The focus group was audiotaped and transcribed verbatim.

Data Analysis

Phenomenology guided data analysis by focusing on patterns across participants' mathematics experiences to detail the phenomenon of mathematics success among these undergraduate Latin@ students (Creswell, 2013). Open codes were used to identify the institutional, interpersonal, and ideological influences on mathematics success while axial codes examined the intersectionality across participants' mathematics experiences (Bowleg, 2008; Creswell, 2013). While some axial codes were specific to individual identities (e.g., race, gender), other axial codes corresponded to different intersections of these identities such as gender-race (Bowleg, 2008). Implicit instances of intersectionality were made explicit by constructing analytical narratives for each participant (Angelillo, Rogoff, & Chavajay, 2007).

Validity was reinforced through triangulation of collected data, memoing, and member checking. I brought awareness of my positionality to pursue data analysis with strong subjectivity and build nuanced understandings of the Latin@ engineering students' mathematics success. In addition, I developed positive rapport and mutual trust with participants supported by our mutual identifications as Latin@ STEM majors.

Findings

The following section presents findings from the analysis of interview and focus group data organized by institutional, interpersonal, and ideological influences on the undergraduate Latin@ engineering students' mathematics success. In alignment with the constructive goals of RUME's preliminary research report presentations, discussion about this subset of the study's data analysis will guide my next research step in triangulating participants' classroom reflections with their observed behaviors in mathematics lectures and recitations/workshops. This will allow for consideration of confirming and disconfirming evidence across data sources to characterize the Latin@ engineering students' strategies in successfully navigating the gendered and racialized spaces of their undergraduate mathematics classrooms.

At the institutional level, participants described how instruction in their mathematics lectures limited their participation in terms of asking questions, volunteering answers, and correcting the instructor. Cristian described how although he "captures little concepts" during lectures, he "do[es] not learn in class" and instead does much of his mathematics learning at home when reviewing his notes. Diana also reflected on how lectures' fast instructional pace caused her to have to write notes without "taking them in or processing them." This resulted in what participants described as quiet mathematics lectures with only a few other students participating – namely, whites and Asian Americans. While Daniel characterized these more active class participants as the "same people who go above and beyond," Cristian asserted that they were the "nerdy kids" from high school who "want to know everything and get the highest grade" which typically did not include Latin@s.

Interpersonally, participants viewed strong relationships with their mathematics teachers as motivation to not let them down and be successful in their classes. They, however, described minimally connecting this way with their undergraduate mathematics instructors. Benito posited that in order to establish strong teacher-student relationships, professors and graduate teaching assistants (not just students) have to "make an effort to build that relationship" which he did not readily observe at the university. As an example of this limited teacher approachability, he commented on how the chemical engineering department attempted to "humanize" its faculty members by mandating them to make small self-introductions including personal interests on the first day of their courses.

Both Cristian and Daniel commented on how having shared racial and gender identifications with their instructors would positively impact their participation and performance in undergraduate mathematics. Cristian, for instance, saw himself being more comfortable and "willing to correct the professor… [if] he is a male professor" considering the underrepresentation of women faculty in mathematics. Daniel looked back on how his former Latin@ college calculus professor's use of the Spanish language and sharing of childhood stories in Honduras separated him from other university mathematics faculty who "felt like robots." It was this professor connection that Daniel raised as an explanation for his "metamorphosis" as a college mathematics student characterized by sitting toward the front in lecture, attending office hours, and ultimately passing first-semester calculus after failing it the first time and being placed on academic probation.

From an ideological standpoint, participants raised the discourse of a racial hierarchy of mathematics ability (Martin, 2009) with whites and Asian Americans being better at mathematics than African Americans and Latin@s. This discourse allowed them to make meaning of undergraduate mathematics classrooms' "competitive" feel and minimal opportunities for peer connection. Diana reflected on how most of her mathematics professors curved course grades so one's performance is contingent on how the entire class

performed. As a result, students were aware of those "at the top" scoring near-perfect exam scores who Diana described as commonly being Asian American classmates "mak[ing] themselves known" by publicizing their high grades. Diana's racialized views of who was successful in undergraduate mathematics brought her to feel as though her classroom participation as a Latin@ was subject to closer scrutiny particularly from white and Asian American peers who were possibly thinking, "Why are you talking?" Cristian asserted that such peer judgments coupled with limited opportunities to connect with other students one-on-one in large lectures often resulted in "closed off" opportunities to study with classmates who he saw as more mathematically capable than him.

Implications for Teaching Practice

Although findings from this study are not generalizable to all Latin@ student populations and higher education institutions, they raise key implications to advance undergraduate mathematics teaching informed by critical awareness of mathematics as a variably gendered and racialized experience for Latin@s and other underrepresented groups. Questions for audience discussion during the RUME presentation are raised throughout this section.

First, the Latin@ participants' reflections on their mathematics lectures resonate with Rasmussen and Wawro's (under review) argument for equity considerations in structuring undergraduate mathematics instruction. I argue that such pedagogical mindfulness, however, should not be limited only to post-calculus courses considering how the Latin@ students expressed limited opportunities to meaningfully engage with instruction in calculus. Furthermore, it is well documented that entry-level mathematics courses like calculus serve as a gatekeeper for underrepresented groups' access to advanced STEM coursework (Chen, 2013). What literature would be useful to further explore values of classroom instruction and student learning across P-16 mathematics? How can university faculty better support Latin@s and other marginalized students whose pre-college mathematics learning approaches may differ from those used to inform undergraduate instruction?

Secondly, participants' discussions of feeling disconnected from their university instructors capture the importance of teacher-student relationships in their mathematics success. This aligns with scholarship that highlights how students of color's academic success is characterized by high-quality instruction coupled with caring, supportive teacher relationships allowing for increased access to mathematics and STEM at large (Battey, 2013; Brown, 2002). To what extent has culturally responsive pedagogy been examined in undergraduate mathematics education? What approaches to undergraduate mathematics instruction establish relational spaces with underrepresented students such that their ability and cultural backgrounds are acknowledged and valued throughout the learning experience?

Lastly, participants invoked gendered and racial discourses of mathematics ability to make meaning of their positioning along a hierarchy of success across undergraduate mathematics classrooms (Boaler & Greeno, 2000; Leyva, under review; Shah, under review). Zoila, for example, shared how she held ideas that "whites and Asian Americans are smarter" making her often feel intimidated by these peers. Such discourses, however, often hindered the Latin@ students from connecting with classmates even though such networking played an important role in their pre-college mathematics success. This challenges Treisman's (1992) claim of students of color as inherently not able to form peer networks and thus raises the question of what practices in undergraduate mathematics teaching can disrupt existing forms of gendered and racialized status of who are seen as "doers of mathematics" in classrooms.

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