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Where is gender? Gender as interaction in mathematics education

Onde está o gênero? Gênero como interação na educação matemática

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ABSTRACT

The article provides a narrative review (Collins & Fauser, 2005) of research related to gender and mathematics education through 2021. The author draws on gender research in sociology and utilizes Risman's (2018a) concept of gender as social structure. The gender as social structure framework is used to categorize and discuss research in mathematics education. The author presents research in three levels of the social structure (micro, interactional, and macro) of which each are comprised of two aspects: the material and cultural. Overall, the author argues for mathematics education to develop theoretical frameworks and methodologies to understand gender in mathematics education at the interactional level.

KEYWORDS: Genders. Interaction. Risman.

RESUMO

O artigo apresenta uma revisão narrativa (Collins & Fauser, 2005) de pesquisas relacionadas a gênero e educação matemática até 2021. O autor baseia-se na pesquisa de gênero em sociologia e utiliza o conceito de Risman (2018a) de gênero como estrutura social. A estrutura de gênero como estrutura social é usada para categorizar e discutir a pesquisa em educação matemática. O autor apresenta a pesquisa em três níveis da estrutura social (micro, interacional e macro), sendo que cada um deles é composto por dois aspectos: o material e o cultural. De modo geral, o autor defende que a educação matemática desenvolva estruturas teóricas e metodologias para entender o gênero na educação matemática no nível interacional.

PALAVRAS-CHAVE: Gêneros. Interação. Risman.

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Introduction

Researchers have argued for a reconceptualization of the way gender is studied in the field of mathematics education (Damarin & Erchick, 2010; Leyva, 2017). Of central critique is the atheoretical and inconsistent way that gender has been applied across studies. Leyva (2017) noted that among the extant literature there are two broad categories that concern either student achievement or student participation. Student achievement data are usually couched in terms of gender but analyze sex-based difference between male and female students. Participation studies have similar issues regarding the conflation of sex and gender. Other analyses have unpacked how mathematics classrooms are gendered experience (Langer-Osuna, 2011; Mendick, 2005; Walshaw, 2001). Still, gender is reconstructed in mathematics education as a boy/girl binary. As suggested by Esmonde (2011), Damarin and Erchick (2010), and Leyva (2017), mathematics education research needs a conceptualization of gender that creates a nuanced understanding of how gender is constructed and mediates learning in the mathematics classroom. In this essay, I discuss trends in mathematics education research by placing gender research within Risman's (2018a) conceptualization of gender as a social structure. By categorizing mathematics education research with Risman's structure, I highlight the need to attend to gender as it is produced in interaction within mathematics classrooms.

Gender (as well as sex) can be defined in a multitude of ways. In the immediately following sections I use gender to mean the social aspects that derive from sex assignment. Sex should be taken to mean the biological categorization typically used in a binary conception of male or female that is decided most often by visible genitalia or chromosomal makeup.

Mathematics and Gender

Schools as sites for the reproduction of social inequalities is not a new idea (Anyon, 1980; Bowles & Gintis, 2011; Rury, 2016). For instance, Thorne (1993) documented the relationships between children in early childhood that crossed gender boundaries and then contrasted these relationships with the inscriptions of a gender binary through classroom and school practices. Richardson (2015) and Pascoe (2007) have documented the ritualization of gender norms in elementary, middle, and high schools through school events (i.e. homecoming, fundraising events). Mathematics itself has been regarded as a masculine discipline (Chapman, 2001; P. Ernest, 1998;

Mendick, 2005) and doing mathematics is often taken as doing masculinity (Chapman, 2001; P. Ernest, 1998; Mendick, 2005; Walshaw, 2005).

Students are often aware of the gendered expectations in school mathematics. Mendick (2005) demonstrated that high achieving male mathematics students used the discipline of mathematics to position themselves as smart and assert masculinity; on the other hand, high achieving girls took nuanced care to describe themselves as mathematics learners (and interested in the subject) as to not lose their femininity. Gender is also a salient topic when students describe their experiences and preferences for working in cooperative groups. Esmonde and colleagues (2009) found that students with marginalized identities (i.e. girls, racially non-dominant) discussed how their identities mediated the ways they contributed or not to groupwork in reflective interviews. Elsewhere, Langer-Osuna (2011) analyzed a mixed-set group of students working together in a mathematics classroom. Over time, the only girl in the group, Brianna, was increasingly marginalized by the group and became known as “bossy.” One particularly interesting aspect of this case is that acts that were read as “bossy” when performed by Brianna were subsequently interpreted as “leadership” when performed by the boys in the group. Brianna’s reflections revealed that she lost a desire to participate in the group because of the way she was positioned and that generally in her experiences the “boys don’t listen to girls… [the boys] think they can control [girls] because they’re the man’” (Langer-Osuna, 2011, p. 220). In short, students are well acquainted with gendered expectations as they learn mathematics. Next, I describe the methods used in my search and analysis. Then I share my categorization of research related to gender and mathematics by introducing gender as social structure (Risman, 2018a).

Narrative Review

This essay is based on a narrative review (Collins & Fauser, 2004) of publications that studied gender in the context of mathematics education. As such, this essay is not a systematic literature review; rather, I seek to broadly describe the landscape of gender research in mathematics education. I used Google Scholar to search the terms “Gender” and “Mathematics Education” through December 2021. I then used a snow ball technique to identify additional articles cited by articles from Google Scholar. Overall, this resulted in 36 reviews. There are several limitations to my review, including reviewing only articles published in English and journal publications which does not account for recent research shared in conference proceedings which may use more progressive methods.

The research question guiding this narrative review is: How does mathematics education research related to gender fit within Risman's (2018a) framework of gender as social structure? To respond to this question, I read each article at least twice. In my first read I attended to how gender was defined and theorized, if at all, data sources, and analytic techniques. I tracked this information in a spreadsheet and wrote a brief memo describing how each article fit, or not, within Risman's concept of gender as structure (see next section). Once I read the entire set, I read the articles a second time to compare to other articles in the search and elaborated on my original memos.

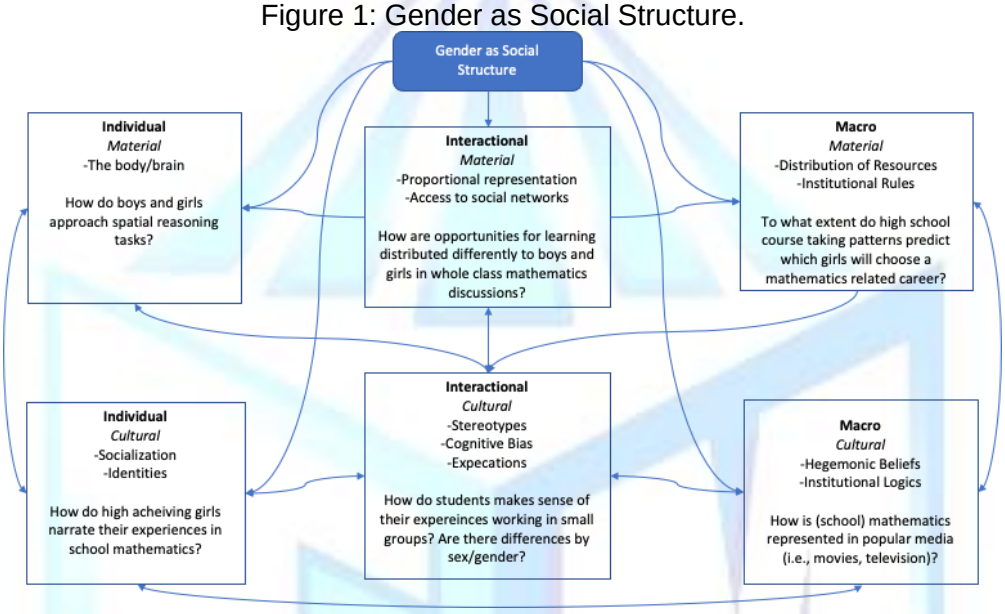
The gender structure of mathematics education research

Comprehensive reviews on the topic of gender in mathematics education (Leyva, 2017; Lubienski & Ganley, 2017) highlight the theoretical advances in this field of research. Overall, these authors note that the notion of gender has evolved from the study of sex-based differences that focus on student achievement, cognitive factors, and course taking differences to the study of the sociocultural gendering that occurs in mathematics contexts. Sociocultural gendering considers the ways societal stereotypes, teacher stereotypes, teaching methods, and teacher-student interactions re-produce gender differences (Lubienski & Ganley, 2017). Leyva (2017) distinguished between studies that focused on student achievement and student participation. The studies classified as student participation were further categorized between sex-based and gender-based participation studies. The sex-based participation studies relied on binary female/male conceptualization which the authors in turn interpreted as gender. In contrast, gender-based participation studies were framed so that the "findings were interpreted using a conceptualization of gender as socially constructed" (p. 400). To interpret gender as socially constructed, researchers theorized gender as an element of identity. In this sense, identity is interactional versus internal. I further illustrate the interactional versus internal distinction through Risman's (2018a) conceptualization of gender as social structure.

Risman (2018a, 2018b), a sociologist of gender, argued that gender is "a stratification system that has implications at the individual, interaction, and macro levels of analysis" (p. 30). The structure of gender is important because it recognizes that "social structures exist outside individual desires or motives and that social structures at least partially explain human action;" that is, "social structures not only act on people; people act on social structures" (p. 30). This model of gender as social structure contains three levels of the gender structure (individual, interactional, and macro), with each level containing two aspects (material and cultural). The material

aspects of gender “include[s] our bodies and the legal rules that distribute physical rewards and constraints in any given historical moment,” whereas the cultural aspects include “the meanings given to bodies and the norms for social interaction and widely shared ideologies” (p. 31). These six categories are each important in understanding how gender stratification is produced, reproduced, and can be resisted. Figure 1 is an adaption from Risman’s (2018a, 2018b) diagram to include research questions in mathematics education that I consider to by typical within each category. Next, I explain each of the categories with examples from mathematics education.

Figure 1: Gender as Social Structure.



Adapted from Risman (2018a, 2018b).

Individual Level

The material aspect of the individual level primarily concerns the body. In gender research writ large, this research is concerned with hormones, genes, and sex organs that refer to sex-categories by understanding relationships with the appearance of such items and how they influence experiences in the world. In mathematics education research, this set of research has sought to understand cognitive differences between research subjects classified as male versus female. An abundance of research in this area has been previously reviewed (e.g., Leder, 2019; Leyva, 2017; Lubienski & Ganley, 2017) and includes sex differences on standardized tests, patterned habits of reasoning while problem solving, and attitudes toward mathematics. The key assumption of this set of gender research is that there is a material aspect, typically measured in a cognitive way, that contributes to a difference between students’ (categorized as male or female) experiences (i.e. level of success, interest) with mathematics. Lubienski and Ganley (2017) note that, “despite gender equity over the

past two decades, small but persistent differences favoring males tend to remain on mathematics assessments in many countries, particularly assessments that are less tied to school-taught materials" and that "sex differences in mathematical confidence and anxiety are larger than achievement gaps" (p. 658). These material differences in individuals exist in patterned ways that are aligned with sex-categories. Analyses at alternative levels of the gender structure are necessary to more completely understand how such differences manifest.

The cultural aspect at the individual level considers an individual's socialization and identity. Broadly speaking, this category considers how culture is internalized by individuals into gendered selves. In mathematics education research, this category is concerned with gendered subjects' self-concept in relation to mathematics. There are not many studies which fall squarely in this category, although Foyn, Solmon, and Braaeth (2018) and Mendick (2005, 2008) are notable exceptions. Foyn et al., (2018) analyzed three Norwegian girls' self-authoring through a theoretical framework that employed figured worlds (Holland et al., 1998) to study identity as constructed during interviews. This study highlighted how high achieving girls negotiated notions of femininity in mathematics classrooms by contrasting themselves with another girl they perceived to be less feminine than themselves. Similarly, Mendick (2005) conducted and analyzed interviews of seven students enrolled in an advanced mathematics course and two students (Mendick, 2008) that had dropped from the advanced course to understand their self concept in relation to being good at mathematics. Mendick (2005) argued that it was difficult for female students to position themselves as mathematically competent because of cultural connotations related to gender and mathematics. Overall, studies that reside within the cultural aspect of the individual level focus analysis on students' constructions of themselves as mathematics students in interview settings. This research draws on the macro level to understand students' self-authoring; however, it is not explicitly about the macro level. There is an abundance of research that explicitly interrogates the interplay between the cultural aspects at the individual level and macro levels. Before discussing this interplay, I will describe research at the macro levels.

Macro Level

The material aspect at the macro level considers how gender as a structure distributes resources and the institutional rules for doing so. In terms of mathematics education research, one resource distribution that is considered is course enrollment. Stearns and colleagues (2020) studied the course taking patterns of college freshman

to determine whether their first-year experience influenced their pursuits in a STEM career. These researchers reported that “the lack of self-efficacy in STEM that many women report–even among our interviewees who were interested in STEM prior to college and/or were highly capable in mathematics–helps so understand the gap in STEM declaration” (p. 247). Similarly, Marsh and colleagues (2019) studied course taking patterns of Australian senior high school students as they transitioned to a university to find that “gender was not significantly related to senior high school STEM course selection” (p. 1644)–yet, young women’s enrollment in STEM courses decreased upon entry into a university system. These two studies illuminate the “leaky pipeline” of the macro structure of gender in mathematics that distributes resources–courses–to males by arguing that previous course selection and prior achievement are not the reasons for the “leaky pipeline.” Marsh and colleagues (2019) noted that, “although gender did not emerge as an independent theme, we believe it was pertinent to note the experiences of young women who, without prompting, spontaneously recalled explicit accounts of gender being a barrier to their entry in STEM at university” (p. 1666). This coincides with findings that the perception of discrimination against women in a STEM discipline is a stronger predictor than sex-category itself to predict who will choose to study a STEM discipline (Ganley et al., 2018). One element of these studies that is important to note is that they frequently rely on a sex-category binary which is reified through survey methods.

Generally, the cultural aspect at the macro level has to do with the hegemonic beliefs and institutional logics that give shape to gender inequality. This aspect considers how Western mathematics is culturally constructed as masculine by the way it is represented in textbooks (Hottinger, 2016; Rubel, 2016) as well as in popular culture, such as movies (Hottinger, 2016; Mendick, 2005, 2006). The cultural aspect is often brought into research to illuminate the interplay among the individual and macro aspects.

The Interplay of Individual and Macro Levels

Researchers have focused on how individuals at various points in their education experience draw on cultural narratives to construct their identities. One set of studies concerns the narratives told by adults with different race and class positionalities (Forgasz, 1998; Siivonen, 2013; Siivonen et al., 2016; Solomon, 2012; Solomon et al., 2016). These studies illuminated that the educational experiences of adults were told through dominant discourses that genders mathematical ability to privilege males. In each of these studies the idea of gender is not explicitly theorized,

but taken to play a structuring role in the narrative identities told by the participants. Another set of studies is focused on students' narrative identities at the university level (Leyva, 2016; Oppland-Cordell, 2013; Oppland-Cordell & Martin, 2015). Within this set of studies, intersectional perspectives (with regard to gender, race, and class) played a prominent role; although, the notion of gender is undertheorized. One notable exception is Leyva (2016) which draws on Butler (1990) to recognize gender as "a social construct discursively produced or performed differently across individuals and contexts" (Leyva, 2016, p. 7). Leyva (2016) draws on discursive productions to highlight the within-group variation of two Latin@ university mathematics students. The discursive production of gender as an element of an individual's multiple identities is a defining attribute of the set of studies about adult and college aged students referenced above.

Researchers that have studied gender at the elementary and secondary education level reveal a similar theme in regard to the production of gender through narrative. Hernandez-Martinez (2008), Lim (2008), Mäkelä and Kalalahti (2020), Mendick (2008), Nuamah (2018), and Williams and colleagues (2009) each used participant's narratives during interviews as the identity that is discursively produced. Although identity is taken within these studies as discursively produced, the production of gender–as an element of multiple identities–however, is not theorized. Gender is taken for granted as a category which is produced by the female research participants. This is evidenced through the fact that in each of these studies, except for Williams and colleagues (2009), only female/girl participants are included. Nuamah (2018) and Mäkelä and Kalalahti (2020) do speak directly to notions of gender, but in a limited way that reduced gender to background characteristics. Markovitz and Forgasz (2017) is another exception in this category of research. Through survey techniques, they studied students' relationships with mathematics to find that girls identified speed, effort, and persistence as important to learning mathematics and were sensitive to challenges; boys, they reported, had higher perceptions of themselves in comparison to their teacher's evaluation. Markovitz and Forgasz (2017) state, "the girls may have already picked up that teachers and parents hold differential, gender-stereotyped, expectations of boys' and girls' mathematics capabilities" (p. 62); however, this study is problematic since gender is not theorized, and the reports of gender differences are reported via sex-based classifications. One alternative interpretation of their report is that these students' ways of discussing their experiences was the performance of gender.

There are four important ideas to take away from my narrative synthesis of these studies. First, the majority of these studies are about girls narrating their experiences in relation to mathematics. This framing implies that the experience of gender is unique to those categorized as girls. Second, categories of male/female and boy/girl are reified as meaningful categories without interrogating how or why these categories themselves have become and continue to be meaningful. One reason for this is related to the following idea. Third, these articles do not explicitly theorize the concept of gender. Gender as used in these studies can be tacitly understood as sex-categories that are used in the process of gendering students' mathematical experiences. Gendering mathematics can be understood as the subjects drawing on cultural discourses of gender and mathematics to make sense of their own mathematical experiences and subjectivity. Gender is used as a category through which both the participants and researchers try to understand individuals' experiences. Even though identity is taken as discursively produced, the production of gender has been limited to the invocation of dominant narratives related to mathematics as a masculine enterprise or conflicting roles such as mothering (gendered as feminine).

Fourth, although identity is sometimes theorized as discursive productions (a la Butler in the case of Leyva (2016), the narratives available through interview methods are limited. Identities in these studies are created in the telling of the narrative. It is important to note that the narrative identity may be different than the identities discursively produced while interacting in a mathematics class. I find that a distinction between narrative and narrated events (Juzwik, 2012) to be useful in seeing the difference in when the identity is created. The discursive identities in the mathematics education research I have discussed above analyze the narrative event–that which is taken as performative are the speech acts that occur during the interview. The actual events and stories that are retold by study participants–the narrated events–are not analyzed as the performance/construction of identity. It is understandable, since the re-telling of past events might not be particularly useful for understanding identity; however, this makes it clear that as a field, researchers need to include different methods to analyze the production of identities and gender in real-time interactions as they are performed in mathematics classrooms. These types of studies would lay within the interactional level of the gender as social structure framework.

Interactional Level

The interactional level of gender captures the experiences that "every time we encounter another human being, or even imagine such an encounter, the expectations

that are attached to our sex-category become salient to us and whether we meet such expectations or not, we are held accountable by ourselves and others" Risman (2018a, p. 32). The material aspect at the interactional level concerns ideas about representation which I consider this to be related to students' access to opportunities for learning.

My review of the literature has not yielded many studies within this part of the gender structure. One noteworthy study is by Ernest, Reinholz, and Shah (2019). In this study, they analyzed the distribution of questions answered by women and the length of students' oral contributions to whole class discussions. Their findings indicated that women made high level contributions in small groups, but those comments were less likely to be shared with the whole class. They also demonstrated that side-talk during class, is which is often interpreted as disruptive or off-task, in many instances was productive sense making. Although the authors claim to "eschew essentialist and monolithic accounts of women's experiences in mathematics" (p. 157), the categorization of women and men and their participation does reify the sex/gender binary; nonetheless, within the strong discourses that describe male and female experiences in a mathematics classroom, this study points to the material ways in which students identified as women are provided less opportunities to answer high-level mathematics questions. These researchers discussed the patterns they recorded in concert with the cultural discourses. They interpreted the differences between women's participation in small- and whole-group discussions as an example of the implicit ways that women are socialized to engage in mathematics class. This relates to the cultural aspect of the interactional level, which I discuss next.

The cultural aspect at the interactional level considers the stereotypes, bias, and expectations for individuals to act and behave in certain ways. It is within these interactions that individuals are expected to do their gender (or any other element of their identity) in a certain way and are held accountable (Hollander, 2013, 2018) to sets of implicit or explicit standards. My review of the literature has not yielded many studies that are focused squarely within the cultural aspect of the interactional level.

Jungwirth (2008) is one notable exception. Jungwirth took an interactional perspective that did not situate gender as an individual characteristic. By drawing on ethnomethodology (Kessler & McKenna, 1978; West & Zimmerman, 1987), gender is theorized as in interactional accomplishment. Jungwirth (2008) states, "Gender does not adhere to individuals, it is an interactively produced entity" (p. 580) and that such an approach to gender "means that there is an entangling of relationships to gender,

and to signs that produce gendered people" (p. 581). In this particular study, Jungwirth analyzed the interactions of students as they completed a mathematics task using a computer to argue that interactions in which students' laid claims to knowledge "intertwines with gender" (p. 586). Laying a claim to knowledge was about individual's rights or obligations to be involved in particular ways; this contrasts with interactions described as "dealing with knowledge" (p. 585) which were about carrying out of tasks or procedures. What is most interesting to me in this study is that gender is theorized as the interaction which created gendered individuals. Yet, the interaction that is provided as the main piece of evidence is between a boy/male, Eric, and girl/female, Erna. The gendering is taken at a moment of conflict between Eric and Erna regarding the use of the computer mouse after Erna made a claim to knowledge about calculating probability. Erna requested to use the computer mouse to correct Eric's solution, but Eric did not comply with the request. This resulted in Erna telling Eric how to correct his method. Eric retained control of the computer mouse. Jungwirth stated, "with the mouse, do's and don'ts are negotiated, and the outcome separates the individuals into one who has the right to use it, and one who does not. This differentiation follows the male-female divide" (p. 587). Jungwirth argued that interactions such as this produce computers as masculine. I wonder, though, how such an interaction between two male students would be interpreted as producing gender.

The Interplay of Interactional and Individual Levels

Researchers have also attended to the interplay between the cultural aspects of the individual and macro-levels. Leder and Forgasz (1997) and Radovic, Black, Salas, and Williams (2017) both attended to the interplay between the individual and interactional levels. Leder and Forgasz (1997) collected video data of students working in small groups, surveys regarding students' attitudes and beliefs, and interviewed students. They reported, through sex categories, differential participation in small groups (i.e. girls completing more peripheral aspects of mathematics tasks) and differences in students' confidence. They claim, "gender differences were also evidenced in both cognitive and affective engagement" (p. 108). The essence of this study is connecting student's self-concept (individual level) to the interactional patterns during small groupwork (interactional level). This study, however, has no clear theorization of gender itself. The categories of boy/male and girl/female are taken for granted as meaningful. This study highlights the distinction I seek to make about gender. The differences of participation, as viewed through sex-categories, is the continual re-doing of gender. I argue for theories and methodologies that do not

presuppose particular genders from the outset. As with Jungwirth (2008), as the students worked on the mathematic tasks–or the peripheral and menial tasks of an assignment–they recreated gender. Students performed their genders differently for various reasons and constraints considering their immediate contexts. Leder and Forgasz (1997) sought to make links to individual's traits such as sex-categories, self-reported confidence, and attitude toward mathematics.

Similarly, Radovic and colleagues (2017) used lesson observation and interviews to understand early adolescent Chilean female's experiences in mathematics class. The researchers conceptualized peer clusters (i.e., friendship groups) to understand how relational aspects influenced girls' "identification with mathematics" (p. 437) and "how these relationships were used to maintain or negotiate different positions of engagement and success" (p. 437). Related to the notion of peer-clusters was the conceptualization of identity as a dialectical process, drawing on figured worlds (Holland et al., 1998). Gender, though, is not theorized in any way and is not related to identity; gender is discussed only as a prevailing social structure influencing the expectations of the girls in this study. This study is noteworthy for other reasons. The notion of peer clusters highlights that not all girls experience mathematics class in the same way. To make sense of their experiences, some girls drew more heavily on gendered discourses than others. These researchers relied heavily on the interview data to understand how girls were making sense of their experiences. The researchers illustrated that the discourse of males' supposed natural mathematics ability was a resource that girls used to justify difficulties in mathematics. Observation data was used for the researchers to identify how other girls balanced mathematical effort with femininity by invoking "gendered practices like dating, partying… and looking pretty" (p. 459).

Alternatively, Gholson and Martin (2019) have provided a unique methodology in their study of a Black girl's (Cameryn) experiences in a mathematics classroom. Gholson and Martin draw on notions of performativity (Butler, 1988) in relation to gender, race, and class which contributed to Cameryn's production of her mathematical identity. Although the authors draw on performativity, they frame Camery's interactions as "performance of gender" (p. 396); however, to Butler (Butler et al., 2004) performativity is not mere performance. Performativity describes that gender is constituted in the linguistic (i.e., repeated speech acts); gender doesn't wait in the background waiting to be expressed in a performance.[i] They analyzed Cameryn's peer-to-peer interactions, teacher interactions, and conducted interviews.

These methods allowed the researchers to describe how Cameryn's interactions constituted her painful experiences in mathematics class. One notable theoretical advancement, moving beyond the linguistic, is that Cameryn's multimodal interactions were interpreted through notions of masculinity and femininity by drawing on the notion of cool pose. Cool pose is "the presentation of self many black males use to establish their male identity" (Majors & Billson, 1992, p. 4) and "a coping mechanism par excellence that some black males have learned to use to help counter social inequality" (p. 116). Its purpose, Majors and Billson (1992) have argued, is to "enhance social competence, pride, dignity, self esteem, and respect. Cool enhances masculinity" (p. 105). Theorizing of gender as masculinities and femininities supported idea that masculinities are not bound to male bodies, nor are femininities bound to female bodies.

The Interplay of Interactional and Cultural Levels

Few studies have considered the interplay between the cultural aspect at the interactional and macro levels. Walshaw (2001) studied the way one girl, Donna, became "gendered through available discourses and practices" (p. 471) in a mathematics classroom. Drawing on poststructuralist theories, Walshaw (2001) used examples of Donna's experiences to reveal the multitude of subject positions that Donna took up within the mathematics class. Walshaw (2001) stated, "What it means for Donna to be female in this classroom depends on the discourse claiming her attention at any one moment" (p. 487) and highlighted the ways contradictory and bumping discourses (Davies, 1998) constructed Donna. This particular study highlights the ways essentialist framings of girls/females ignores the complex and contradictory discourses and experiences in mathematics classrooms.

In this section I have categorized mathematics education research related to gender by using Risman's (2018a) conceptualization of gender as social structure. Through this categorization I have synthesized the literature to demonstrate that, overall, gender and mathematics education researchhas tended to focus on gender at the individual and the macro levels, and the interplay between these two levels. Moreover, gender is generally taken as the study of females' experiences and the primary method of inquiry is through narrative and reflection. These studies highlight the difficulties females continue to endure in mathematics classrooms; however, these studies do not reveal how these difficulties arise in the everyday interactions of mathematics classrooms. Based on this review of literature, I argue that gender and

mathematics education researchers should take up theories and methodologies that focus on gender at the interactional level.

Toward gender as interaction

As discussed above, few researchers have attended to the gender in mathematics education at the interactional level. To theorize gender at the interactional level, I propose theorizing gender as a discursive production by employing Butler's (1988) notion of performativity. As such, gender does not exist prior to the interaction– it is within the interaction that gender is (re)produced. As argued by Leyva (2017) and Damarin and Erchick (2010), researchers at the intersection of gender and mathematics education need to strive to provide clearly articulated theoretical orientations. Darragh (2016) argued for the potential to use performativity in mathematics education identity research and several scholars have taken such approaches (Chronaki, 2011; Gholson & Martin, 2019; Leyva, 2017). I argue by drawing on performativity, similar to Gholson and Martin's (2019), there are methodological advantages to analyze the real-time interactions (as opposed to reflections) of students in mathematics classrooms. This will help the field to move beyond narrative inquiries in which only the narrative event is taken as performative. Moreover, on studies that employ narrative, male/boy/man and female/girl/women were often taken as common-sense categories that labeled study participants. I challenge the field to offer analysis of identities (gendered subjectivities specifically) as they occurred within interactions. This will allow the field to develop understanding about how common-sense gender categories get recreated through interactions.

I am not arguing that research at the individual and macro levels are not important nor that we fully understand those levels; rather, I argue that by looking more closely at students' interactions within mathematics classrooms we might understand how the binary sex-categories and gender categories become meaningful for participants in those interactions. By understanding the interactional level, we might more fully be able to understand how the macro level of gender persists as well as how it contributes to individuals' experiences, perceptions, and sense of self (individual level). Further, gender is not a phenomenon relevant to only girls/females. For instance, how are masculinities/femininities negotiated within mathematics classes among students of all genders? Close analysis at the interactional level can help the field of mathematics education to understand how dominant notions gender get taken up and employed in mathematics classes. To close I offer potential ways for the field to move forward.

First, analysis at the interactional level should not rely on only the researchers' interpretations of students' interactions. As Baxter (2003) argued, analysis should be multi-voiced. Further, analysis should not rely on the "outward appearance" (Paechter, 2006, p. 258) since gender is "fundamentally about how one is recognized by other" (p. 258). In this sense, studying gender at the interactional level should engage at least two perspectives: those reading the performance as well as the intent of the person performing. One possible method is video-cued ethnography (Tobin & Hsueh, 2007).

Secondly, notions of femininity and masculinity are constantly changing and highly contextual (Pascoe & Bridges, 2016). Performances of gender are different across contexts – and the meanings of the same interactions might be different in an alternate place, time, or between a different set of students. Gender as the constellation of masculinities and femininities might be productive by drawing on Bakhtinian (1981) notions monoglossic and heteroglossic discourses. For instance, gender heteroglossia and gender monoglossia can be useful to see the complexity– and subtlety– of students' interactions Francis (2010). This also has the potential to bring into focus students that are marginalized in different ways, but in ways related to gender. For instance, non-dominant boys and/or gender queer students. In this regard, Bakhtinian frameworks have potential to build an anti-genderist mathematics education (Esmonde, 2011) and help to loosen the grip on essentialist arguments about girls' and boys' ways of knowing and/or their actions in mathematics classrooms. However, researchers should remain mindful of the ways masculinity and femininity depend on the thick and always-already available discourses of gender which reify the male/female binary. In turn, obscuring other ways of being that do not rely on a gender binary. This potentially dismisses genderqueer students as invisible. The field of mathematics education should seek ways to understand the gendered experiences of genderqueer students that do not rely on their conformity within the dominant discourses of masculinity and femininity.

Lastly, the intersectional identities of the students will influence the interpretations among interactants. Leyva (2017) argued for the use of intersectional perspectives in gender and mathematics education research. In expanding the way discourses related to gender is conceived, the body can be a communicative resource (Fisk & Ridgeway, 2018) analyzed in part through multimodal analysis (Norris, 2011). It is important to account for the ways that raced bodies are used to interpret students' actions. For instance, Ferguson (2000) has demonstrated the ways that Black students' are mis-interpreted as older and more aggressive, and subjected to harsher

discipline. Majors and Billson (1992) have documented a style of Black masculinity, cool pose, used to navigate oppressive conditions. Racial ideologies and varied versions of masculinities and femininities cannot be ignored.

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