MATHEMATICS TEACHER
# Learning & Teaching PK-12

*Mathematics Teacher: Learning and Teaching PK-12*, is NCTM's newest journal that reflects the current practices of mathematics education, as well as maintains a knowledge base of practice and policy in looking at the future of the field. Content is aimed at preschool to 12th grade with peer-reviewed and invited articles. *MTLT* is published monthly.

ARTICLE TITLE:

## Supporting LGBTQ+ Students in K-12 Mathematics

AUTHOR NAMES:

E. Waid, Brandie

DIGITAL OBJECT IDENTIFIER: 10.5951/MTLT.2019.0403

VOLUME: 113

ISSUE NUMBER: 11

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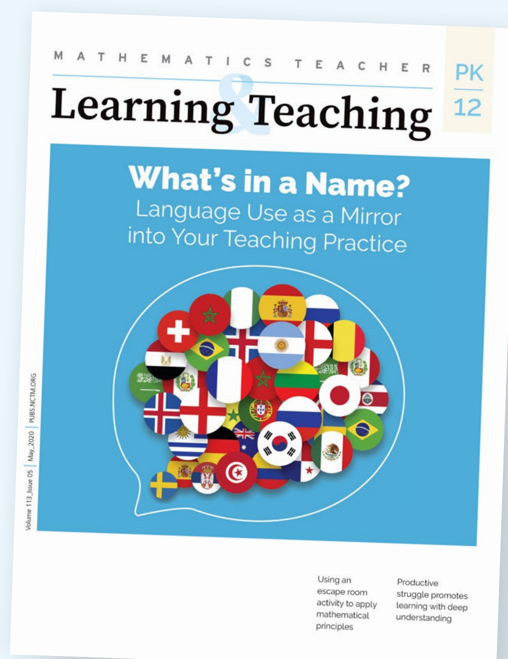
Approved by the NCTM Board of Directors on July 15, 2017.

CONTACT: mtlt@nctm.org




NCTM NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS


# Supporting LGBTQ+ Students in K–12 Mathematics

**Strategies range from engaging in self-education to creating inclusive classroom spaces and adopting inclusive curriculum and pedagogy.**

Brandie E. Waid

**As my eighth-grade** students worked on their assigned problem set, a student caught my attention. She pointed to a problem and asked, "Ms. Waid, how would you define a couple?" The problem, from Park School of Baltimore's (2006, p. 15) mathematics curriculum, read, "At a school dance, there are X boys and Z girls, and there are more boys than girls. How many different possible couples for dancing are there?"

My student's question hit me like a brick. I managed to respond, "How would you define a couple?"

Another student snapped, "A couple is any two people, male or female. That is the only way anyone should define a couple."

The original student, now hesitant, responded, "But isn't the problem easier if I say a couple is a boy and a girl?"

I would like to say that I used this opportunity to engage the class in a conversation about how not all couples are heterosexual, to talk about the social construct of gender, and to work toward building a culture of acceptance and support for LGBTQ+ students and families. I would like to say that I used this opportunity to talk about how the assumptions we make (influenced by implicit bias) can change the mathematics required by a problem. However, I did none of these things. I vaguely remember asking the students to record assumptions they made, but otherwise this became a missed opportunity. The interaction left me reeling.

At this point in my career, I had only recently come to terms with my own queerness and had "come out" to many of my colleagues, friends and much of my family but was not out to my students. What rattled me, however, was not the opportunity to share my identity with my students. I believe that every LGBTQ+ educator should decide for themselves if and when to reveal such information. Instead, it was my own assumptions that struck me. When selecting the problem, my recognition of the required mathematics led me to overlook the possibility of anything other than a heterosexual coupling. As a result of this interaction, I began to reflect on my identity and the ways in which my K–12 education had deemed my queer identity irrelevant to my mathematical identity. This set me on a journey to better understand how I could support LGBTQ+ students in my mathematics classes.

## GENDER IDENTITY AND SEXUALITY IN MATHEMATICS

Although it has not always been the case, much of the mathematics community now agrees that mathematics is not neutral, free of culture and other elements of identity. This position is reflected in the National Council of Teachers of Mathematics (NCTM) position statement on Access and Equity:

> Creating, supporting, and sustaining a culture of access and equity require being responsive to students' backgrounds, experiences, cultural perspectives, traditions, and knowledge when designing and implementing a mathematics program and assessing its effectiveness. . . . Addressing equity and access includes both ensuring that all students attain mathematics proficiency and increasing the numbers of students from all racial, ethnic, linguistic, gender, and socioeconomic groups who attain the highest levels of mathematics achievement. (NCTM 2014, para. 1)

This indicates a necessary step toward attaining educational equity, but one group has been noticeably absent from talks of access and equity in mathematics education—LGBTQ+ students (in this article, mentions of LGBTQ+ students also include students from LGBTQ+ families).

One might argue that gender minorities are included in NCTM's position on equity and access because the statement explicitly refers to *gender*. Historically, however, our society has failed to include gender minorities in talks of gender equity. In fact, at the time this article was written, the Supreme Court had only recently decided that transgender identities (and other LGBTQ+ identities) are covered under the Civil Rights Act, in relation to job discrimination. In the mathematics education community, references to gender have also lacked a broader conception (outside of the male/female binary) and the concepts of gender and sex have often been conflated (Leyva 2017). Although some recent studies have begun grappling with the social construction of gender and how individual men and women position themselves "along the gendered and racialized hierarchy of mathematical ability" (Leyva 2017, p. 417), discussions of gender remain largely within a male/female binary.

One might argue that sexual orientation and gender identity have no bearing on teaching and learning, but a great deal of research counters this argument. Research indicates that the current climate of many schools in the United States has further marginalized LGBTQ+ youth. According to the 2017 National School Climate Survey (administered every two years by the LGBTQ+ organization GLSEN), a majority of LGBTQ+

**Brandie E. Waid**, bew2126@tc.columbia.edu, is an assistant professor of teacher education at Drew University in Madison, New Jersey. She previously taught middle and high school mathematics in both New York City and Florida. She is interested in the ways in which students' multiple identities manifest in mathematical spaces and methods of humanizing mathematics for all students, particularly LGBTQ+ students. She can be found on twitter at @MathTeach_BEW.

doi:10.5951/MTLT.2019.0403

students (8 in 10 of those surveyed) reported experiencing harassment or assault at school due to their sexual orientation or gender identity, with "transgendered students experienc[ing] a more hostile school climate than all other students" (Kosciw et al. 2018, p. 85). Such experiences contribute to LGBTQ+ individuals' higher risk of poor academic performance, truancy, and depression and to higher rates of school disciplinary action for LGBTQ+ students. This propels a disproportionate number of LGBTQ+ students into the school-to-prison pipeline (Palmer and Greytak 2017; Snapp et al. 2015). Reported rates of punitive disciplinary action are higher for LGBTQ+ students of color, making them particularly vulnerable (Kosciw et al. 2018). Given this information, it is apparent that having an LGBTQ+ identity affects the learning experiences of an individual, particularly LGBTQ+ students of color and transgender students.

In addition to the larger body of research that supports how having an LGBTQ+ identity affects the general learning experiences of students, evidence suggests that LGBTQ+ identities play a role in STEM education. For example, Greathouse and colleagues (2018) found that fewer LGBTQ+ students (40%) choose STEM majors than their non-LGBTQ+ peers (47%); and Hughes (2018) found that of LGB students that do select STEM majors (transgender individuals were not included), fewer persisted in those majors than their non-LGB peers (63.8%, as compared to 71.1%). Given these findings, we see that STEM fields are not only masculine and white spaces (Leyva 2017) but also heteronormative and cisnormative. This heteronormativity and cisnormativity begin in secondary education (as indicated by the underrepresentation of LGBTQ+ students selecting STEM majors) and extend to postsecondary education (as seen in a fewer number of LGB students who persist in STEM majors). How do we address this?

## INITIAL CONSIDERATIONS

Before any suggestions are provided for how mathematics teachers can work toward supporting their LGBTQ+ students and disrupting the hetero- and cisnormativity in mathematics, it is important to acknowledge that this article will take the stance that *all* teachers can engage in this work. I acknowledge, however, that a number of states exist in which talking about LGBTQ+ topics in the classroom is prohibited by law. GLSEN's (2018) Research Brief on "Laws that Prohibit the 'Promotion of Homosexuality' in Schools" outlines states that currently have such laws and describes the scope of those laws (e.g., some apply only to sex education). At the other end of the spectrum are states that have passed laws requiring students to learn LGBTQ+ history. Currently, those states include Illinois, New Jersey, Colorado, Oregon, and California. This does not mean that those teaching in the so-called "No Promo Homo" states cannot engage in LGBTQ+ inclusive practices or that those teaching in states that have passed LGBTQ+ inclusive laws must adopt every LGBTQ+ inclusive practice proposed in this article. In my experience, all-or-nothing mentalities can lead to teachers relying on excuses for what they cannot do or feeling overwhelmed by everything they could do.

In my work with teachers, I suggest that teachers begin by reflecting on their context to understand what beginning steps they may take toward creating inclusive LGBTQ+ spaces. If the teacher is living in a "No Promo Homo" state, their early efforts may focus on self-education. Later, they might move toward adopting elements of inclusive classroom culture. To aid teachers in these beginning steps, which are essential for the success of later strategies suggested in this article, I have included a number of resources in appendix A (see the supplementary materials) that can be used for both self-education in LGBTQ+ experiences and terminology and to create more inclusive classrooms for LGBTQ+ students. Once teachers have engaged in these first two steps, they may find that state laws prohibit them from including explicit LGBTQ+ representation, but they *can* remove problems that reinforce heterosexual couplings and the gender binary.

This approach is similar to Miller's (2019) discussions of supporting LGBTQ+ students in English language arts and is inspired by Hermann-Wilmarth and Ryan's (2015) call for teachers to "[do] what you can." Hermann-Wilmarth and Ryan state the following:

> We want to move teachers from considering *whether* they can include particular lessons or particular texts in their instruction to *how* they might find multiple, even creative ways to address the larger systems that enable homophobia and heterosexism in the first place. (p. 436)

In addition to homophobia and heterosexism, I would also add transphobia and cissexism to this statement.

Such a directive indicates that although teachers must consider their context, they cannot stop at a simple asking of pronouns at the start of the year or displaying an affirming poster. These practices alone do not address those larger systems of oppression in a meaningful way. In addition to the above mentioned, non-content-specific approaches to supporting LGBTQ+ students, two mathematics-specific strategies support LGBTQ+ students: (1) providing LGBTQ+ inclusive curriculum and (2) queering mathematics pedagogy.

## LGBTQ+ INCLUSIVE CURRICULUM

Inclusive curriculum "enable[s] the student to look through window frames in order to see realities of others and into mirrors in order to see [their] own reality reflected" (Style 1996, p. 1). For LGBTQ+ students, such a curriculum serves to "create a more positive environment and healthy self-concept . . . while also raising the awareness of all students" (GLSEN 2014, p. 33). At present, the field of mathematics education pays little attention to providing such windows and mirrors to LGBTQ+ students. This is evident by the binary presentation of gender and the assumed heterosexuality encountered in mathematics problems (Yeh 2017; Esmonde 2011). The problem in the opening scenario is an example of such problematic assumptions; such problems not only lack representation but also do not reflect the complexities or realities of our society.

The first step in addressing the lack of windows and mirrors in mathematics curricular materials is to assess the problems that we pose and reflect on how gender norms, the gender binary, and heteronormative values may be perpetuated in those problems. To do this, teachers might make a list (maybe one unit or lesson at a time) of any problems, scenarios, or examples that mention genders, make use of "boy" or "girl" names, require gender coupling or pairing, and highlight LGBTQ+ representation. In reflecting on the gendered items, teachers can ask the following:

1. Do these problems reinforce cisnormativity and the gender binary?
2. Do the problems assume heterosexuality?
3. Do these problems reinforce gender norms (e.g., Are "girl" names associated only with playing with dolls or other stereotypical "girl" activities)?

These questions will allow educators to remove harmful representations (those that are stereotypical or reinforce gender norms, cisnormativity, and heteronormativity) and determine areas where positive LGBTQ+ representations might be lacking. For items that include LGBTQ+ representation, teachers can ask, "Is LGBTQ+ representation limited to individuals who are able-bodied, white, male, and/or cisgendered?" and "Is LGBTQ+ representation negative or limited to tragedy (e.g., HIV)?" If the answers to these questions are "yes" or "mostly," then greater or different representation is needed.

Examples of LGBTQ+ representation in mathematics curricular materials are lacking, but some exist. One example, created by Rands (2013), illustrates how secondary teachers might make use of GLSEN's National School Climate Survey in a lesson on statistical concepts. Rands's lesson focuses on a single item from the 2009 administration of the survey, asking students to report how often peers intervened when someone made a hurtful remark about an individual's gender expression. Rands suggests that teachers launch the investigation by assessing students' prior knowledge in the areas of gender expression and stereotypes and on how to intervene if they witness harassment or bullying of another student. Rands then proposes that the teachers use data presented by Kosciw and colleagues (2010, p. 18) in relation to this question (see figure 9, p. 20, of The 2009 National School Climate Survey), as well as the total number of surveyed respondents to create statements such as "In all, 3,580 out of 7,261 students reported that other students never intervened when a student made negative remarks about someone's gender expression" (Rands 2013, p. 116). The teacher would have students use these statements to discuss mathematical ideas such as interpreting the meaning of the statements, creating and analyzing various graphical displays, and concepts of sampling.

Another secondary level example, this time of a task, that includes LGBTQ+ representation is Harper's (n.d.) "What's a Fair Housing Wage?" Harper adapted this task from "The Big Race," in *College Preparatory Mathematics 1* (Sallee et al. 2002), which has students use algebraic concepts to determine who will win a race. To determine this, students are given six cards outlining the profile of an individual in the race (e.g., their speed and starting location). Harper's modified task has students wrestle with the idea of a fair housing wage. Instead of racer profiles, the students receive family profiles, one of which highlights a Black family with two moms. The information on each card is used to determine the affordability of appropriate housing for the family. Harper's example might benefit from a broader conception of gender (all working adults are identified as male or female), but it does include LGBTQ+ representation. Harper's example also illustrates how a mathematics teacher might adapt existing curricular items to include LGBTQ+ representation, even items that may not have originally dealt with gender, family, or sexuality.

At the elementary level, Rands (2009) provides a number of examples for increasing LGBTQ+ representation:

1. Include LGBTQ+ flags and symbols in geometry lessons focused on finding the area and perimeter or fractional concepts.
2. Investigate the fraction of books in the school library that includes LGBTQ+ vs non-LGBTQ+ characters and families.
3. Investigate local newspapers to calculate the percentage of articles that feature LGBTQ+ people and determine what percentage of those articles represent their LGBTQ+ identities in a positive manner.

Rands discusses how the second and third examples provide opportunities for action and activism (e.g., students might write letters to their school board or local newspapers to petition for more positive representation of LGBTQ+ people). Although Rands discusses this for only the third example, both examples two and three would also benefit from taking an intersectional lens to analyze representations of LGBTQ+ people of color and LGBTQ+ people with disabilities.

### Creating Your Own LGBTQ+ Inclusive Examples

The examples above are an excellent starting point for teachers to begin exploring what LGBTQ+ curricular representation might look like, but more examples are needed. For this reason, educators must create (and share) their own mathematical examples of LGBTQ+ representation. Such examples might be created by adapting existing tasks or lessons, as was illustrated by Harper's (n.d.) "What's a Fair Housing Wage?" Or teachers might create new tasks on the basis of LGBTQ+ symbols (e.g., gender symbols or LGBTQ+ flags) or scenarios involving LGBTQ+ people (e.g., What mathematics is involved in planning the Pride Parade or in LGBTQ+ family planning?). Creating examples, however, is no easy endeavor. For this reason, I will present a task that I have created for use in a fourth-grade elementary class and model my thinking processes during the task's development. My hope is that this will help teachers conceptualize how to create their own LGBTQ+ mathematical examples. I have also included thoughts on how the task might be enacted in the classroom, but every teacher will require their own adaptations to meet the needs of their students.

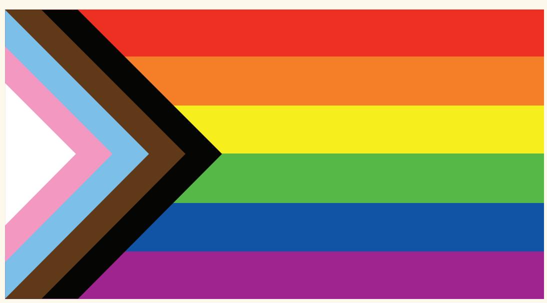
The task I have created makes use of the Progress Pride flag, shown in figure 1. The flag was created by nonbinary designer Daniel Quasar and contains elements of three existing LGBTQ+ flags: the Rainbow Pride flag, the Transgender Pride flag, and the Philadelphia Pride flag. Video 1 describes the history and meaning of the Rainbow flag, video 2 is an interview with the creator of the Transgender Pride flag (Helms 2015), and video 3 offers information released by the public relations firm (Tierney 2017) that created the Philadelphia Pride flag.

In describing the Progress Pride flag, Quasar (2018a) stated the following:

> The main section of the flag (background) includes the traditional 6 stripe LGBTQ flag as seen in its widely adopted form so as not to take away from its original meaning. The trans flag and marginalized community stripes were shifted to the Hoist of the flag and given a new arrow shape. The arrow points to the right to show forward movement, while being along the left edge shows that progress still needs to be made. (para. 6–7)

Although not everyone in the LGBTQ+ community has adopted Quasar's flag, I have been drawn

*Fig. 1*



*"Progress" Pride Flag by Daniel Quasar 2018 (quasar.digital LLC).*

***Video 1*** History and Meaning of the Rainbow Flag (2015) (https://youtu.be/TWZMLzkdzxg)

Watch the full video online.

***Video 2*** An Interview with Monica Helms (https://youtu.be/UJ-Rq3Bl_UY)

Watch the full video online.

***Video 3*** Philadelphia's More Color More Pride Campaign (https://youtu.be/0EiZmcel9po)


Watch the full video online.

to the flag for a number of reasons. First, I appreciate Quasar's attempts to spotlight the struggles of transgender people and people of color within the LGBTQ+ movement and signal the work that still needs to be accomplished. LGBTQ+ spaces and advocacy have often (both historically and today) centered the experiences and needs of White, cisgender males, serving to exclude and further oppress people of color, transgender, and gender nonconforming individuals and (at times) women, within the LGBTQ+ community (Irazábal and Huerta 2016; Rosenberg 2016). I am also intrigued by Quasar's flag for its numerous algebraic and geometric properties (e.g., symmetry, parallel lines, similarity, etc.). Developing a mathematical task that explores these properties provides not only opportunities for mathematically rich discussion but also space to talk with students about connections between symbols and identity, serving as a tool to rehumanize mathematics (Goffney, Gutiérrez, and Boston 2018).

## Designing the Task

The elementary school task I designed was inspired by my own noticing and wondering about the symmetrical properties of the flag. In searching the elementary grades Common Core State Standards (NGA Center and CCSSO 2010) for geometry, I located the following standard:

> CCSS.Math.Content.4.G.A.3: Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry.

While looking at the Progress flag in relation to this standard, I wondered if students who had previously learned the "rules" of how many lines of symmetry exist in various polygons (squares, rectangles, triangles, etc.) would at first think that the flag had two lines of symmetry since it is rectangular in shape. A discussion of the flag might correct that misconception. I also wondered how many students would identify the line connecting the yellow and green stripes as a line of symmetry. I had, at first glance, identified this as a line of symmetry but then began wondering, "Do the colors matter?" If the colors matter, then the flag has no line of symmetry. If the colors do not matter, then the flag does have a line of symmetry. Looking back at the standard did not help me answer this question. The standard makes note of “matching parts,” but what does it mean to match? Do colors matter in a match? These felt like questions a fourth grader would pose. How might a teacher handle such questions?

As I researched to solve my conundrum, I discovered that my question was related to concepts of abstract algebra, specifically related to the mathematical art of Escher (EscherMath 2015). Two terms used to describe symmetry in such settings, *color-preserving symmetry* and *symmetry of the outline*, seemed accessible to a fourth grader. Color-preserving symmetry is described as “points that correspond under each symmetry are the same color” (para 1. under “Color and Symmetry”) and symmetry of the outline as “[a] symmetry you would get by completely ignoring the colors” (para. 1 under “Color and Symmetry”). I developed the Progress Pride Flag task (see figure 2) with my above wonderings and discoveries in mind.

## Enacting the Task

Before a teacher introduces the Progress Pride Flag task, I envision that they would first show students a number of symbols, some with which they may be familiar and some with which they may not (e.g., flags from various countries or cities, religious symbols, gender identity symbols, symbols associated with professions, etc.). Students would be invited to share what they know about these symbols, allowing the teacher to assess their understanding of the symbols’ significance. Next, the teacher would facilitate a class discussion on the importance of symbols and how, for some, symbols are seen as a connection to an individual’s identity. Students would be invited to share any symbols with which they find connection, and how those symbols are related to their identity. The teacher can also invite students to notice the mathematical properties of the symbols (e.g., “What shapes are involved?” “Is there any symmetry?”) to have students begin “mathematizing” the images. Following this discussion, the teacher would show students an image of the Progress flag, discussing its meaning and history (see discussion earlier in this article). Part 1 of the task would be launched after this discussion.

Part 1 has students consider the shapes included within the flag’s design, the attributes of those shapes, and if they notice any lines of symmetry. Students should be encouraged to work on part 1 in pairs or small groups and then come back together to discuss as a class. While working in their groups, students might benefit from receiving a paper copy of the flag for use during their symmetry investigation. Upon reconvening the class for discussion, the teacher would elicit students’ understanding of

***Fig. 2***

**Progress Pride Flag Task**

Part 1
What shapes can you see in the Progress Pride flag?
What are the attributes of each of the shapes?
Does the flag have any lines of symmetry? If so, where? If not, why?

Part 2
Create two examples of images that have color-preserving symmetry.
Create two examples of images that **do not** have color-preserving symmetry.
Create two examples of images that have symmetry of the outline.
Create two examples of images that **do not** have symmetry of the outline.
What would the Progress Pride flag need to look like to have color-preserving symmetry?

Part 3
Think about your own identity (who you are as a person). Draw a flag that represents your identity and that has at least one line of symmetry.
Is the symmetry in your flag a symmetry of the outline or a color-preserving symmetry? Explain your reasoning.

*The author developed the Progress Pride Flag task with her own wonderings in mind.*

the three questions for part 1. In discussing the last question, the teacher should assess any misconceptions that students might have (e.g., “There are two lines of symmetry because the flag is a rectangle”). During the discussion of the last question is when students may ask the previously posed question, “Do the colors matter?” If a student does not pose this question, the teacher should pose the question to probe their thinking for part 2. This would also be an opportunity to go back and review the class definition of symmetry (particularly if the “matching parts” definition of the Common Core State Standard is used) and discuss the importance of precision in mathematical definitions.

Before introducing part 2 of the task, the teacher would introduce the definitions of color-preserving symmetry and symmetry of the outline. The Progress Pride flag would be used to conceptualize these definitions because it is an example of symmetry of the outline, but not of color-preserving symmetry. After this discussion, the teacher would allow students to attempt part 2, again in pairs or small groups. After attempting part 2 in their groupings, students would reconvene for a whole-class discussion. The first questions allow students to create their own examples and nonexamples of each of the newly introduced definitions. During the class discussion of such examples and nonexamples, it may be interesting to ask students if an image that has color-preserving symmetry always has symmetry of the outline and vice versa. This might also serve as an extension question for groups that finish part 2 before their peers.

The final question in part 2 assesses students’ ability to draw line symmetrical figures and revisits the idea of a flag’s connection to identity. To revisit these connections, the teacher would ask, “What is the significance of the colors of the Progress flag? How would changing the colors change the meaning?” Such questions allow students to remember the significance of LGBTQ+ identity that this flag represents. The question also leads to part 3, which invites students to create a flag that represents some aspect(s) of their own identity and contains at least one line of symmetry. They are asked to identify their line(s) of symmetry as a symmetry of the outline or a color-preserving symmetry. Parts 1 and 2 of the task were completed in small groups or pairs, but students should be encouraged to create their own individual flags for part 3. These flags would then be presented and displayed in the classroom upon completion.

## QUEER THEORY INSPIRED PEDAGOGY

The above examples, in which the focus is to increase LGBTQ+ representation, are referred to by Rands (2009) as the *add-queers-and-stir* approach. Although this method provides windows and mirrors of LGBTQ+ identities, some might argue that increasing representation does not do enough to dismantle the power hierarchies of society’s heteronormative and cisnormative framework and is bound to fall short of a truly inclusive curriculum (Rands 2009; Gunckel 2009). As a queer Latinx woman who never saw my own identity represented in my K–12 schooling, I agree with this assessment. Consequently, I have struggled over the last few years to find an approach that moves beyond inclusion and works to rehumanize mathematics for *all* students.

To address shortcomings of the add-queers-and-stir approach, Rands suggests a method referred to as *mathematical inqu[ee]ry*, inspired by queer theory and queer pedagogy. Unlike the add-queers-and-stir approach, which attempts to normalize various sexualities and gender identities, queer theory calls for rejecting notions of normal (Jagose 1996). Queer pedagogy describes the application of queer theory to teaching practice and calls into question the nature of knowledge and learning (Britzman 1995) in much the same way as teaching through inquiry (Gunckel 2009; Nelson 1999). A queer pedagogy works to expose and disrupt the power hierarchies of education by bringing into question the knowledge and ways of learning that we

Some might argue that increasing representation does not do enough to dismantle the power hierarchies of society’s heteronormative and cisnormative framework.

have internalized, both inside and outside of school. In relation to gender and sexuality, Keenan (2017) discusses such internalized notions as "scripts" about our bodies and explains how such scripts are learned from the onset of children's education, namely, in the gender roles and norms that are reinforced as "normal." In essence, the add-queers-and-stir approach seeks to add certain marginalized identities to the "script" of identities that our society deems normal or acceptable. As a result, other identities will remain at the margins. A queer pedagogy resists this temptation and instead serves to reject (rather than revise) such scripts and resists replacing them with new notions of normal.

Applying this to mathematical pedagogy, Rands (2009) describes mathematical inqu[ee]ry as "questioning the tasks, the strategies, the very ways of thinking and doing mathematics, as well as the way mathematics is used to interpret and act in the world" (p. 186). This brings to mind Su's (2020) description of *mathematical explorers*. Su argues that exploration is a key component to human flourishing and, "the only requirement to be a math explorer is the ability to ask questions like *Why?* and *How?* and *What happens if* . . . ? All children do this, yet somewhere along the way, some stop asking questions" (pp. 25–26). Mathematical inqu[ee]ry, as described by Rands, encourages a pedagogy that nurtures this natural tendency to question and supports children to flourish as mathematical explorers.

Rands's description of mathematical inqu[ee]ry also brings to mind the eight dimensions of rehumanizing mathematics for Black, Indigenous, and Latinx students, as discussed by Gutiérrez (2018). By its questioning nature, mathematical inqu[ee]ry is related to dimension 1 (participation and positioning) because adopting a questioning stance shifts the power hierarchies within the classroom, allowing students to take the ownership of their learning. The practice also acknowledges and encourages students to tap into their funds of knowledge, in relation to both their cultures and lived experiences (dimension 2). Similarly, mathematical inqu[ee]ry recognizes mathematics as a living practice (dimension 4) by allowing students to see mathematics as "full of not just culture and history, but power dynamics, debates, divergent answers, and rule breaking" (p. 5). Additionally, it encourages students to broaden mathematics (dimension 6) by questioning its very essence. Such questioning will likely promote creation (dimension 5), by ultimately "encourag[ing] students to invent new algorithms or forms of doing mathematics that are consistent with their own values" (p. 5). By tapping into these dimensions, mathematical inqu[ee]ry serves as a tool to rehumanize mathematics not only for Latinx, Black, and Indigenous students but also for LGBTQ+ students.

## How Might One Engage in Mathematical Inqu[ee]ry?

Rands's conception of mathematical inqu[ee]ry extends beyond gender and sexuality (Rands provides examples of queering time and measurement as a means of mathematical inqu[ee]ry). However, my discussions of mathematical inqu[ee]ry in this article will remain limited to gender and sexuality in order to illustrate what such a practice may look like in the classroom. To begin this process, I turn to Waid and Turner (forthcoming), who developed cross-disciplinary questions that teachers might use to interrogate gender and sexuality in classroom texts. Those questions include the following:

1. What do you notice?
2. What do you wonder?
3. What is the context?
4. What genders are represented, and how are they presented?
5. Who is included in the represented genders and who is not?
6. What other genders are there?
7. What would considering other gender identities (not just male and female) add to our understanding? (p. 14)

To conceptualize the use of these questions in mathematics, I return to the couples problem presented in the opening scenario. Turner and Waid's first two proposed questions are simply an "I Notice, I Wonder" routine (NCTM, n.d.), allowing teachers to glimpse how students conceptualize the problem, with a focus on the mathematics and the elements of gender and sexuality present. In the couples problem, the third question, "What is the context?", might refer to the physical context of the problem (school dance), the "boys and girls" at the dance, or the mathematical concepts and tools that the students have already encountered and possess. All these factors influence the assumptions that students make as they engage with the problem.

The fourth, fifth, and sixth questions serve to challenge the assumptions that students made in their initial reading of the problem. While discussing these questions, students would also benefit from questions about sexuality (e.g., "What is the nature of a couple?") and who is included in the terminology of "boy" or "girl" in the problem. This is where a mathematics teacher might also pose the question, "What assumptions might we make and why is it important to acknowledge our assumptions before we attempt a problem?" The final question, "What would considering other gender identities (not just male and female) add to our understanding?" might be an entry point to discuss how one might reframe the problem to broaden their thinking and how this would change the mathematics required. After such discussion, students might be encouraged to revise the problem and solve their revision.

Posing such questions in relation to the couples problem serves two purposes. The first is to teach students that mathematics can (and should) be used to critically engage with the world. Second, this sort of engagement allows students to consider the importance of assumptions within a mathematical context, and how our bias might affect our assumptions, even in mathematics.

Although the couples problem may be more suitable for middle or high school students, Waid and Turner's (forthcoming) questions may be adapted for use at the elementary level. I will illustrate such an adaptation in reference to two problems (shown below), from the New York State Department of Education's (2015a; 2015b) EngageNY curriculum for grades 3 and 5 (respectively).

> Problem 1: "There are 83 girls and 76 boys in the 3rd grade. How many total students are in the 3rd grade?" (p. 20)
>
> Problem 2: "There are 48 students going on a field trip. One-fourth are girls. How many boys are going on the trip?" (p. 109)

These problems may not contain elements of sexuality, but they both reinforce binary conceptions of gender. An elementary school teacher taking an add-queers-and-stir approach might omit these problems from their curriculum, rewrite the problems to include greater gender representation, or rewrite the problems to omit gender entirely (e.g., If there are 83 green boxes and 76 blue boxes, how many total boxes are there?); however, a teacher engaging in mathematical inqu[ee]ry might use the problems to work toward dismantling students' developing scripts about gender.

Using Waid and Turner's (forthcoming) cross-disciplinary questions, a teacher would begin asking students questions one and two, "What do you notice?" and "What do you wonder?" in relation to the problem. Next, an elementary teacher might adapt the third question, "What is the context?" and instead ask, "What information are we given?" and "What are we trying to find?" This is when students might focus on the number of boys or girls in the problem and the desired outcomes of total students (in problem 1) or the number of boys (in problem 2). Next, the teacher might ask, "What genders are included in the problem? What genders are not?" These questions are similar to Turner and Waid's cross-disciplinary questions 4 and 5. Students could respond in a number of ways. They might think in terms of whether or not numbers are given for the boys or girls. For example, a fifth-grade student might say neither boys nor girls are included in the problem because an exact number of girls are not *given* (though it can be found) and you have not yet solved for the number of boys. Such a response informs a teacher that the initial questions may need rephrasing or further explanation for this student.

Students might also answer that all genders are included since both boys and girls are mentioned. Such a response would expose what students have internalized about the concept of gender. Additionally, if students have learned about genders outside of the boy/girl binary, know someone who identifies outside of that binary, or they themselves identify outside of the binary, they may indicate that nonbinary, gender fluid, agender, or some other gender identity is not represented in this problem. Either of these scenarios enables a teacher to introduce (or reinforce) students' broadening conceptions of gender (WelcomingSchools.org has excellent resources for this). This allows the teacher to pose Turner and Waid's sixth cross-disciplinary question, "What other genders are there?" (p. 14).

Once students have reviewed or learned about genders outside of the binary, the teacher might ask, "How would thinking about other genders (not only male and female) change this problem?" This is a slight adaptation of Turner and Waid's final cross-disciplinary question. The teacher might help students think about this question by encouraging them to consider certain elements of the problem (e.g., What does "total" mean? How can we find a total if we have only the number of boys and the number of girls?). This complicates students thinking and helps them think like a mathematician, considering a broader (more realistic) range of variables. After discussing students' ideas, the teacher might ask students to rewrite the problem in a way that makes more sense, given the existence of more than two genders, and then solve their problem. Such a task is open-ended, so students will likely rectify the underlying binary assumption of the EngageNY (New York State Department of Education 2015a, 2015b) problems in a variety of ways. For example, one student might write a problem that includes other genders (e.g., nonbinary); another student might simply include a statement such as “There are only boys and girls in this class” (thus acknowledging that other genders do exist).

Although the previous two examples described possible progressions at the secondary and elementary levels, for using Turner and Waid’s cross-disciplinary questions, we should not expect mathematical inquiry to be prescriptive. Instead, the questions are a basis that teachers might use to probe into students’ thinking. As teachers use some or all the questions to elicit student ideas, they must make sure that they are using those ideas to determine the trajectory of the discussion and not simply sticking to a script of the cross-disciplinary questions. We must not treat mathematical inqu[ee]ry as if the teacher is learning knowledge about LGBTQ+ people and then transmitting that knowledge to their students. Our students have their own ideas about gender and sexuality, and even if we are unaware of any LGBTQ+ students in our classroom, it is likely that they are there. Mathematical inqu[ee]ry instead should be used as a tool to amplify student voices and to help LGBTQ+ students feel valued as members of our mathematical communities.

## CONCLUSION

This article presents a number of ways that mathematics teachers can support LGBTQ+ students. Such strategies begin with teachers educating themselves on the terminology and experiences of LGBTQ+ people and creating inclusive classroom spaces for their LGBTQ+ students (resources for this have been included in appendix A). In addition to these items, teachers have been presented with two mathematics-specific means of supporting LGBTQ+ students: (1) LGBTQ+ inclusive curriculum and (2) queering their pedagogy. Although teachers must decide for themselves how, when, and to what extent to implement these strategies in their classroom, it is important to remember that *all* of us can do something to support LGBTQ+ youth. As scholar shea martin (2019) notes,

> We must no longer depend on the outness of LGBTQ+ educators and students to determine the need for inclusion in our learning spaces. As a community, we are all responsible for inclusion and making our LGBTQ+ students feel seen, heard, and affirmed (regardless of their visibility). (para. 10–11)

It is every teacher’s responsibility to prevent students from developing the belief that their LGBTQ+ identities have no place in mathematics, as I was led to believe in my own K–12 education.

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