Poetic Mathematical Knowledge, Cultural Connections and Challenging Epistemic Injustice

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Abstract

This article focuses on poetry as a shared point of mathematical reflection, connection, and culture while discussing the importance of the driving force behind liberatory action. Specifically, a math-inspired poetry template will be discussed across multiple learning contexts to highlight the richness of poetry and math. We put forth the idea of Poetic Mathematical Knowledge to provide an entry toward transformational mathematical teaching and learning rooted in resistance, healing, and liberation. Insofar to say that antiracist mathematics must move beyond superficial activities and must focus on the wholeness of students and their communities.

Discussion And Reflection Enhancement (DARE) Pre-Reading Questions

1. How do your students reflect on mathematics?
2. What are the connections between mathematics and poetry?
3. What role does poetry serve in the knowledge and understanding of anti-racist mathematics teaching and learning?
4. How (and why) do you identify and acknowledge multiple forms of culture and knowledge in your classroom?

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Poetic Mathematical Knowledge

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"I do consider myself a poet, mathematician and scientist."

- High School Student

Anti-racist mathematics must address the root causes of societal injustices for the inclusion of social justice in mathematics to have a lasting and sustained impact. When mathematics teachers think anti-racist mathematics teaching, do they think about a single social justice lesson connected to a particular topic, or are they thinking of ways the mathematical learning can help students better understand and challenge racism and other structural forms of oppression? Individual lessons on social justice are essential but they are only a small piece of what is needed to create spaces for students to liberate themselves. Imagine doing a math lesson on racism in the United States in your classroom or even a year dedicated to how mathematics can be used to show and understand racism. Yet did you ask yourself how racism impacts your classroom and the lives of your students? Enter anti-racist teaching, which requires an ideological shift, a commitment from teachers to improving the lives of students and their communities in and outside of the classroom. Anti-racist mathematics is not just a lesson it is the teacher's pedagogy, an acknowledgment that racism is real and present in every classroom, the classroom environment, the multiple power dynamics of student relationships in and out of the classroom, and a commitment to eliminating racism and other forms of structural discrimination. Teachers must work towards both having a commitment to social justice and a critique of societal oppression, what Solórzano and Bernal (2001) call transformational resistance. Our approach suggests that even though inclusion of social justice lessons in mathematics classrooms is a meaningful way to teach mathematics, students deserve more than one or two lessons to grapple with societal issues. Students deserve experiences that help them better understand themselves, their classmates, their community, the larger socio-cultural context, and mathematics. Discussing the root causes of societal injustices and connecting them to the context of your students as a teacher can be difficult without an ideology of anti-racism but it is needed if we want to strive towards actions that challenge racism.

The I Am Math Poem activity (IAMP) highlighted in this article presents an entry to paradigms that seek to engage anti-racist mathematics at the epistemic level in moving beyond performative social justice mathematics. The epistemic level represents the foundational knowledge (or action) used to construct new knowledge and meaning-making. For example, in mathematics, we have axioms like the communicate property that helps us build and discover new mathematical theorems, where axions can be viewed as the epistemic level. Epistemic justice are acts of justice built on a solid foundation, requiring an understanding of injustice to ensure acts of social justice do not perpetuate previously unacknowledged and unknown forms of injustice (Medina, 2012). In other words, we want to ensure our work, and the work of anti-racist mathematics, starts from a place that is not rooted in injustice to ensure we are not perpetuating unknown harm. IAMP addresses epistemic injustice by using poetry to allow teachers to understand better how students see mathematics, and by providing an activity that was developed to help students form collectives engaged in positively transforming the world. IAMP was created as part of a summer critical youth mathematics program for Black, Native, and Latinx high school-aged students to collectively identify and begin to dismantle problems across their own school district. The program will be referred to in this paper as REALM, Reflection Equals Action in Liberatory Mathematics (see Martinez, 2020 for more details about the program).

The use of poetry allows for a deeper exploration of self, mathematics, and the social world. IAMP is one example of Poetic Mathematical Knowledge (PMK), discussed later, as a first step towards contributing to anti-racist mathematics. During REALM, after utilizing the IAMP template (see Appendix), one young person wrote "I do consider myself a poet, mathematician, and scientist" after they wrote the following poem:

I am from stars
from where my father taught me,
to add teddy bears.

Celebrating the difference between me, my friend Victoria
And a rainbow is like math,
When trying to learn Algebra
Or enjoying the Pythagorean theorem
And fighting to solve decimals.

We are from math and monopoly
Hidden numbers, I spy glitter
Seeing patterns everywhere, especially at the beach
And when I smell vanilla
Even when smelling poop

Math is me, beautiful
And math is you honest and funny
From negative to positive infinity
Math is all of us, as we become scientists

For, I am math
and
Together we will change world hunger

Pause and take a moment and ask yourself what you know about this young person after reading their poem. Ask yourself how your students may be similar or different. How do you and/or your students reflect on mathematics? Which line(s) stood out to you? What connections between math and poetry are you seeing? What other question comes to your mind?

In the next section, we introduce a concept called "Poetic Mathematical Knowledge" to highlight the union of mathematics and poetry before diving into the IAMP template. In discussing how poetry can function as an embodiment of and vehicle for anti-racist praxis (action and reflection), along with the benefits of poetry in general, we want to situate PMK as a critical lens to view mathematics and poetry.

Poetic Mathematical Knowledge

The process of writing and performing poetry is a deeply reflective process where writing poetry can shed light on oppression, can be healing (Walkington, 2021), and can be an act of resistance (Baxley & Sealey-Ruiz, 2021). Poetry allows people to communicate complex structural issues in society in that "poetry has a particular way of sustaining and healing our souls by serving as a tool of resistance (Baxley & Sealey-Ruiz, 2021, p. 313)." Specifically for young people, opportunities to perform poetry are spaces of agency and identity development where young people share frustrations and insights on life (Davis, 2018). In talking about the needs of women, Lorde (2000) states, "poetry is not a luxury. It is a vital necessity of our existence. It forms the quality of the light within which we predicate our hopes and dreams towards survival and change, first made into more tangible action. Poetry is the way we help give name to the nameless so it can be thought (p. 372)." What Audre Lorde captures arrives at an investigation of epistemic injustice through the process of poetry, in that writing poetry allows people to develop their voice (LaBonty & Danielson, 2004). Hearing poetry performed allows for the sharing of lived experiences, which can build empathy, and can create a collective understanding and acknowledgment of systemic issues in society. The communal sharing of poetry "works as an offering of the spirit on behalf of the collective members, as each person shares aspects of themselves with the group (Ayala & Zaal, 2016, p. 3)." During poetry readings, both the performer of the poem and the listeners of the poem equally benefit from the process, making poetry a healing event (Walkington, 2021) for all.

The blending of poetry and mathematics is rarely seen such that it is easy for people to separate the mathematician from the poet and the healing power of poetry from mathematics. In support of poetic modes of knowledge construction, Taylor (1997) states:

> Poetic knowledge is not necessarily a knowledge of poetry but rather a poetic (a sensory-emotional) experience of reality. … Poetic knowledge is a spontaneous act of the external and internal senses with the intellect, integrated and whole, rather than an act associated with the powers of analytic reasoning … In other words, it is the opposite of scientific knowledge. (p. 5).

In our view, PMK is poetic knowledge that is scientific as it embraces the tensions between scientific (mathematical) knowledge and "non" scientific (mathematical) knowledge to center the relational and transformative nature of mathematics. We want mathematics to be a reflective, collective, and healing experience for students, similar to the benefits poetry offers young people.

PMK is important in mathematics education because it contributes to the classroom environment by giving students the space to show who they are. Anti-racist mathematics is impossible in a classroom where the teachers do not know the students and their desires to challenge injustice. For example, the poem shared earlier shows the young poet's care for world hunger. Poetry allows students to be seen by their peers and teachers while allowing them to see their teacher when they, too, become mathematical poets. We recommend that teachers use IAMP with their students and not shy away from sharing their poems.

IAMP seeks to bridge the more artistic, spiritual nature of poetry with the common (limited) view of mathematics as rational and logical. Mathematics and poetry allow students to practice using mathematical terms such that students gain a new appreciation of mathematics (Keller & Davidson, 2001); they can be used to pose mathematical questions about real-world issues related to societal injustices (Lesser, 2019); and can be used to reflect upon the possibilities of mathematics education (Martinez, 2021). Furthermore, PMK allows for poetry to be influenced by mathematics to gain a deeper awareness of how mathematics can function in paradigms of anti-racism in education. In parallel, PMK allows mathematics to influence poetry, where mathematical terms can enable students to reflect on their lives and the mathematical world.

On multiple levels, the goal of drawing on PMK in the classroom through an activity such as the IAMP is to grapple with mathematical spiritual wisdom defined as "the cultural, historical, spiritual, and logical forms of mathematics that are collectively created to interconnect us to other forms of mathematics (Martinez, et al., 2021, p.77)." IAMP is an example of how mathematical poetry can be utilized to improve how students see themselves as mathematicians and poets connected to a larger interconnected social context and introduce another dimension of creativity to mathematics classrooms. The IAMP template (see Appendix) was designed to learn more about students through various prompts, which are offered as a starting point but open for students' interpretations.

IAMP provides multiple opportunities to just learn about your students. The activity can be done in at least two ways. You can give students the template as is and let them fill in the blanks, or you can ask them the questions ahead of time when they do not know their answers will be inserted into a poem, not unlike the word template game MadLibs. Five years of teaching experience using IMP with youth and preservice teachers shows that giving them the template is more engaging, but you must remind students that they do have the power to change words and interpret each prompt however they want.

Each fill-in-the-blank prompt was designed to learn more about students and their thoughts about math. For example, three lines of the activity directly ask students to identify *a high school or college math class, a math concept that you enjoy doing, and a math concept that you do not enjoy doing.* This not only provides the teacher with information about how students are feeling about math but also provides students with opportunities to learn about each other's feelings about math. Shraddha used IMP with their high school students by having each of them share their poems with the whole class, where one student a week would share their poem. More recently, students were excited about the poems and requested if they could have two students read their poems each week. This shows students wanted to learn more about each other by sharing their poems (PMK).

We can see that many IAMP prompts, such as *an object from growing up*, *a game you like playing, your favorite place growing up, your future career, a positive characteristic that describes, something in this world you want to change,* and *a cultural figure of your people* give students a rare opportunity to share who they are, their culture and their aspirations, and relationships that matter to them, in a mathematics learning context. As one youth stated, they like the activity and the "feeling of being able to express who I am and what makes me me." One of the REALM youth shared their thoughts on IAMP, saying "finding the similarity between math and everyday life really opened my eyes to see how math can be applied to every aspect of our lives - even our feelings. In that case, I do consider myself a poet because to me mathematics is like poetry." Here we see PMK in that the IAMP activity allowed a young person to see mathematics as part of their everyday life, including their feelings. We cannot commit anti-racist mathematics if we do not know how to communicate our feelings about societal injustice.

The template ends with a yearning for transformation by allowing students to think about the future and what

they want to change about it. In the K-12 classroom, it is crucial to ensure any social justice lesson the teacher wants to do aligns with the interests of students if the teacher seeks to have an anti-racist classroom. The prompts in the template were simultaneously designed to pull generative themes from students. Generative themes in the sense of Freire (1978) emerge from the people. In our case, as teachers, they come from our students and are a starting point to make connections between their experiences and the socio-political context of their everyday lives (Ayala & Zaal, 2016). If we are committed to anti-racism in mathematics education, we must allow students to explore what they care about, not just the issues the teacher values. Students cannot be empowered with scripted social justice, and it is inherently disempowering if students do not have a say in what they are learning.

We want to highlight the prompt *cultural figure of your people* by explaining how and why the language was selected because it may sound awkward. Nine out of ten times, I (Ricardo) am asked to clarify "cultural figure," but it is an important opportunity. It is essential first to unpack the phrase *"your people,"* which came from the language of the youth. Your people or finding your people reflects the importance of finding people with the same values and interests. During REALM, all youth were either Black, Native, and/or Latinx, yet even within the same racial group, the youth were looking for their people. For example, a group of Latinx youth bonded over Anime and Manga, so for them, your people was more about Manga than being Latinx. The prompts intend to center culture, hence the phrase "cultural figure." IAMP seeks to center ethnicity, the cultural-historical reality of people, while shifting away from using race as a classification for individuals.

IAMP was originally part of a ten-day, forty-hour math experience, where prior to the activity, youth had engaged in conversations about the multiplicity of culture, such that youth had no issues with the prompt. If anything, they were allowed to flourish, as seen in the earlier poem, where their cultural figure was a rainbow. A rainbow for this young person was an opportunity for them to share their pride – the culture they chose to speak of was LGBTQ culture. When using IAMP with individuals with limited views of culture, the prompt "cultural figure of your people" becomes an opportunity for them to learn through a moment of struggle. Based on my experience using this template in the classroom where all students are white preservice teachers, it is essential to let them work on IAMP for about three minutes and then make an announcement of what is meant by *"cultural figure of your people."* I tell students culture is more than being a person of color or being a non-person of color and that there are sub-cultures and countercultures; even with sub-cultures, they have their sub-culture. I then tell students that, at times whiteness makes it easy not to acknowledge the culture you (white people) have. I follow up by telling them that they are more than just white people. This is a needed step if we want to engage in anti-racist education because viewing culture as being only skin color is how white supremacy erases the culture of people who are white. But, if you decide to modify the template, we recommend changing the prompt to "an important person from your culture," and making sure to unpack what is culture.

IAMP, like any social justice or critical lesson, is not the key to empowering students because no magic empowerment activity exists. Only students can empower themselves, and as facilitators of mathematical knowledge, all we can do is create opportunities for students to empower and liberate themselves. IAMP provides one way of leveraging PMK to create experiences for students to see themselves as poets, mathematicians, and more. PMK then becomes a source of resistance and healing for students to challenge injustices. Thus, as students share what they want to change in this world and begin working with others, they can engage in mathematical learning that feeds their needs.

IAMP can also be used with pre-service teachers to gain a deeper understanding of mathematics. For me (Cayley), math has always been a hard subject. As a student in an elementary mathematics methods course, writing this poem, reading my poem, and hearing the poems written by my classmates gave me insight into their lives, their culture, and their feelings about math. Each person's poem was unique and special. It shows us their feelings about math and tells a story of who they are. Our poems differ because we all have different experiences growing up, and that is something that can be celebrated through IAMP and PMK. These experiences of math and poetry shape who we are and who we become.

Educators impact students' lives enormously and can affect what words they choose for the blanks. We can either make math a positive or negative experience which will be reflected in our students' poems. Finally, we as educators need to know as much about our students as we can, and the IAMP activity helps us do that and can help students learn about the teacher when teachers share their poems. Using IAMP with pre-service teachers allows them to explore PMK while gaining an activity they can do with their future students. A pre-service elementary mathematics teacher was asked if they would use this activity in their future classroom and replied, "Yes [because] it allows students to realize what is important to them and how powerful their presence in the classroom can be." This shows the benefits and impact IAMP has on students and future teachers.

Poetic Mathematical Knowledge and Anti-Racism in Mathematics

The blending of poetry and mathematics is also something we rarely see because we tend to separate the mathematician from the poet. IAMP is one way to create positive images of the unification of mathematics and poetry by allowing students to be poets in mathematical learning spaces. In speaking on the poetic-aesthetics, and creative images Keating (2012) states they "are interrelated to intuitive-emotional knowledge and conscious awareness (p. 53)." The intuitive-emotional knowledge and conscious awareness of poetry is the same ideological posture of the poet-mathematician under paradigms of PMK and, in general what we should see in mathematics.

PMK is the tension between mathematical knowledge and knowledge perceived to be non-mathematical. Understanding how to commit anti-racist mathematics requires an analysis of how mathematics is not only used but how it is lived. Anti-racist education must take into account the lived experiences of those living and resisting societal injustices. Those who experience injustice have a more robust understanding of the problems and have unique solutions to address the root causes of the problem. Speaking of the importance of spaces for Black women preservice teachers, those in the margins, Harmon and Horn (2021) state, "[b]y sharing experiences, individuals can build hope by better seeing the systemic nature of the racism they encounter, helping to depersonalize it. (p.113)." Poems and poetry events are moments where experiences are shared and personal reflection allows people to depersonalize what they have experienced, to better understand systemic issues. PMK seeks to make mathematics another learning experience for people to empower themselves by giving students opportunities to reflect on the world of mathematics and by having them share their contributions (poetry) with society. PMK provides teachers, future teachers, and students with marginalized identities an opportunity to share their expertise, knowledge, and collective hope.

Ultimately, it is vital for all of us as mathematics teachers to epistemically understand the root causes of problems impacting our students and their communities. IAMP and other poetic-mathematical explorations allow students to reflect upon what they experienced to understand issues in their lives. More so, mathematics without poetry, music, and the arts is a limiting scope that fails to encompass emotional-spiritual knowledge in the teaching and learning of mathematics. PMK centers creatively where "[t]he creative work of musicians [poets] and composers inspires us to think about how our own work can foster change (Aronson, et al., 2021, p.273)." In line with Lorde (2000), PMK is a vital component of our existence and builds on our hopes and dreams toward survival and the realization of change. The amalgamation of mathematics and poetry creates a safe space where students and teachers can reflect and grow as people committed to changing unjust educational systems. PMK seeks to be a healing process in exploring self, mathematics, and others in creating new knowledge that is performed and shared with others. As a result, a central goal of PMK is the interconnectedness of all people, meaning it requires a commitment to anti-racist practice and being from all of us.

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Discussion And Reflection Enhancement (DARE) Post-Reading Questions

1. What new connections do you see between mathematics and poetry (e.g., see bottom of https://www.ams.org/programs/students/math-poetry), and how is poetry connected to moments of anti-racist reflection and action?

2. In what other ways has poetry been used in the teaching and learning of mathematics?

3. After completing the I Am Math Poem template yourself, which prompt was the most difficult for you to respond to?

4. What other forms of art might help students reflect and connect with anti-racist mathematics?

Appendix

I Am Math Poem Template

I am from _____'s
(Your favorite shape)

from where my _____ taught me,
(Family member)

to add _____
(An object from growing up)

Celebrating the difference between me, my friend _____
(The name of one of your friends)

and _____ is like math,
(A cultural figure of your people)

When trying to learn _____
(A High School Math or college Class)

or enjoying _____
(A math concept that you enjoyed doing)

and fighting to solve _____
(A math concept you did not like doing)

We are from math and _____
(A game you like playing)

Hidden numbers, I spy _____
(A real-world object that matches your favorite shape)

seeing patterns everywhere, especially at _____
(Your favorite place growing up)

and when I smell _____
(Something that smells nice)

even when smelling _____
(Something that smells bad)

Math is me, _____
(A positive characteristic that describes you)

And math is you _____ and _____
(A characteristic that you like in others) (Another characteristic that you like in others)

From negative to positive infinity
(a characteristic that you like in others)

math is us, as we become _____'s
(Your future career)

For, I am math

And

together we will change _____
(Something in this world you want to change)