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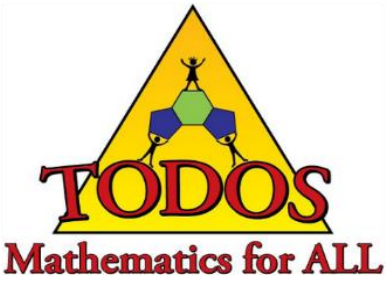
Teaching for Excellence and Equity in Mathematics



An Affiliate Organization of the National Council of Teachers of Mathematics

TEACHING FOR EXCELLENCE AND EQUITY IN MATHEMATICS

IN THIS ISSUE

From the Editors

Dear *TEEM* Readers,

Thank you for engaging with our latest issue during this very challenging period for our nation and for our educational system. As its name indicates, *TEEM* stands, and always has, for excellence and equity in the teaching of mathematics, qualities that are systematically being dismantled. As our local schools lose funding; our grants and those of our colleagues are canceled; we see decreased federal oversight for civil rights; and supports for our public school students, especially BIPOC, LGBTQ+, and students with disabilities, disappear, our hearts are heavy, but *TEEM* continues to pursue its mission.

Before we tell you about this issue and thank everyone who was involved with bringing it to life, we would like to invite you to tell us what you need from us at this time. For example, are there types of articles that are especially relevant for us to publish right now? Should we consider publishing work without identifying the author's name or institution? How can we help more voices be heard, especially now as so many are silenced? Is there anything else we should be doing or thinking about?

What is New With *TEEM*?

First, we are excited to announce that the special issue on Funds of Knowledge honoring the late Dr. Luis Moll and edited by Crystal Kalinec-Craig, Carlos LópezLeiva, and Carlos Nicolas Gómez Marchant, will likely be published in early 2026. Second, as we continue to look for ways to bring relevant work to *TEEM* readers beyond traditional articles, we invite articles that present implementations of activities and ideas featured in previously published *TEEM* articles. For example, if you implemented a lesson from an article or incorporated a *TEEM* article into your curriculum in a meaningful way or with insightful results, it might be worth writing about. As a reminder, we also invite creative submissions in the form of stories, poems, and visual arts. If you are not sure if your idea for a submission will work or fit, please contact us. More information about *TEEM* and the submission process is available on our website. We encourage you to consider submitting an article to and reviewing for *TEEM*. We strive to make the submission process as accessible to authors as possible, and are always interested in submissions from classroom teachers and first-time authors. We have created a submission checklist and an article template to minimize the guesswork for the authors about what they need to submit. Please make sure to use the checklist and template to make the copy-editing, layout, and proofreading processes easier for Associate Editor, Lawrence M. Lesser, and Layout Editor, Susie W. Håkansson, who work tirelessly to make sure that each issue of *TEEM* looks good and is error-free.

About the Current Issue

This issue of *TEEM* is published through Open Journal Systems (OJS). All issues of *TEEM* are freely available to all readers, and readers can download entire issues as well as individual articles. You can find the current and previous issues at the TEEM homepage. Special thanks go to Journal Manager Jordan Register, who ensures that the online platform is running smoothly. Please note that *TEEM* does not have a fixed publication schedule, and that a new issue is published whenever we have enough articles (this is another reason you should consider submitting an article, so that we can publish more frequently). However, OJS allows us to post individual publication-ready articles on the *TEEM* website before an entire issue is ready, so authors can share their work sooner.

As in our last issue, we want to take this opportunity to thank all the previous editors and editorial panelists whose vision had made *TEEM* into the journal it is today. We refer readers who are not familiar with the history of *TEEM* and its past leadership to the article "Still TEEM-ing with Enthusiasm: A History of TODOS' esTEEMed Journal," which can be found on page 37 of TEEM 14(1).

And finally, here is an overview of the four peer-reviewed articles *TEEM* 16(1) contains:

The article "Using Memes to Open Spaces for Critical Conversations about Mathematics," authored by Greg Benoit, K. Elizabeth Hammonds, Gregory Beaudine, and Gábor Salopek, describes the "What Does This 'Meme' to You" task, which uses memes to elicit and reflect on students' perspectives on mathematics.

In a timely article "Mathematics Teacher Leaders' Responses to Equity in Turbulent Times," Kelsey Quaisley, Rachel Funk, and Wendy M. Smith (Quaisley and Funk are both first authors), use the innovative tool of poetic transcription to analyze and represent data on how K-12 mathematics teacher leaders grapple with issues of equity amid attacks on education and on educational equity.

In "Teaching Preservice Early Childhood and Elementary School Teachers Mathematics through a Social Justice Lens," Christopher Yakes and Julie Klipfel share their experiences in developing a mathematics content course focusing on issues of social justice. They provide and reflect on a number of assignments created for the course and student responses.

Finally, the article "Leveraging Children's Multicultural Literature to Support Students' Math Identity and Problem Solving," authored by Margarita Jiménez-Silva, Suzanne Abdelrahim, Rachel Restani, Robin Martin, and Tony Albano, explores how multicultural children's books can be used in mathematics instruction to deepen conceptual understanding and foster positive math identities. Through a classroom vignette using the book *Too Many Tamales*, the authors illustrate how culturally relevant stories provide meaningful contexts for problem solving, discourse, and identity development.

As always, we are extremely grateful for the dedication and expertise of all our reviewers and authors. We are also very appreciative of the excellent editorial support provided by Associate Editor Lawrence M. Lesser and Layout Editor Susie W. Håkansson. *TEEM* gratefully acknowledges the support of all the leaders in our sponsoring organization, TODOS: Mathematics for ALL. We hope *TEEM* continues to serve the TODOS membership and that this issue serves as a resource for the community and a source of inspiration for future contributions to the journal. We stand in solidarity with our colleagues and our students and continue to advocate for culturally-sustaining, socially just, and antiracist mathematics education.

Ksenija Simic-Muller, Editor-in-Chief,
and the four *TEEM* Editors

Using Memes to Open Spaces for Critical Conversations About Mathematics

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Abstract

For better or worse, teachers are not the only ones delivering messages about mathematics; media and social media routinely disseminate messages related to narrow views of mathematics and stereotypical portrayals of mathematicians. These messages can reinforce unproductive cultural beliefs and structural norms in mathematics education which has the potential to influence student achievement and motivation in mathematics. Thus, it is important that we, as a mathematics education community, begin to analyze, decipher, and scrutinize those messages. This article concentrates on creating spaces for students to hold conversations about mathematics through the use of Internet mathematical memes; since, messages generated from memes can be powerful and have the potential to influence one's mathematics experience and one's perceptions of who can become a mathematician. This article will demonstrate how incorporating memes in the classroom can invite students to discuss authentic uncensored thoughts, curiosities, and uncertainties about mathematics as well as the people who do well at it.

Discussion And Reflection Enhancement (DARE) Pre-Reading Questions

1. What impact do you believe social media has on your students' mathematical experience?

2. Is it worth exploring different messages students are receiving about mathematics and the people who do well in it? Why?

3. How do you create spaces for students to openly reflect on and/or debrief their authentic thoughts, curiosities, and/or uncertainties about mathematics, how mathematics is taught, and who does well in it?

Gregory Benoit (gbenoit1@bu.edu) is a lecturer in mathematics education at Boston University Wheelock College of Education & Human Development as well as the assistant director for the Earl Center for Learning & Innovation. He is interested in understanding and designing expansive mathematical spaces that nurture strong positive mathematics identities for both teachers and students. With a strong commitment to creativity, equity, and justice, Dr. Benoit critically examines mathematics popular culture artifacts as a way to design spaces that center the culturally responsive teaching of mathematics.

K. Elizabeth Hammonds (hammoke@auburn.edu) is a STEM education consultant and a Ph.D. Candidate at Auburn University. She has formerly served as an Assistant Professor at Columbus State University, a mathematics specialist at the Alabama State Department of Education, and a secondary mathematics teacher. Elizabeth's research interests include Internet mathematical memes, beliefs about mathematics and mathematics education, and equitable mathematics instruction.

Gregory Beaudine (gregory-beaudine@uiowa.edu) is a Clinical Assistant Professor in Mathematics Education at the University of Iowa. Throughout his academic research at Michigan State University, Morehead State University, and now

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Iowa, Dr. Beaudine has explored how students read mathematical texts and how societal "truths" change the way one views mathematics or themselves as a mathematician. Most recently, he has connected with these other amazing colleagues to tease out how mathematical memes are, can be, or should be used in academic spaces.

Gábor Salopek (Gabor.Salopek@tc.columbia.edu) is a Mathematics Education Researcher from the Mathematics, Science and Technology Department of Teachers College, Columbia University. His research explores identity development in mathematics education, with particular focus on the impacts of mathematics portrayal in social media and technology on academia. Dr. Salopek utilizes his research and experiences in gifted education learning, mathematical identities, popular culture, and academic technology in the classroom to ground an approach to teaching and professional developments.

Using Memes to Open Spaces for Critical Conversations about Mathematics

Gregory Benoit, K. Elizabeth Hammonds, Gregory Beaudine, and Gábor Salopek

As young people navigate media, more specifically social media, they are routinely exposed to a variety of mathematical artifacts and messages, some of which support narrow perspectives and stereotypical portrayals of mathematicians (Benoit & Salopek, 2023; Hall, 2021; Hall & Suurtamm, 2020; Moreau et al., 2010). For example, the image of the "gifted" mathematician is pervasive in popular culture (Moreau et al., 2010; Wilson & Laterrell, 2001), but is synonymous with being crazy or a nerd. It is impossible to "protect" students from unsympathetic mathematical messages they may come across. With no formal space for young people to debrief these messages, thoughts or sentiments, students are left to their own devices as to if, how, and where they deliberate these messages. One concern is that unsympathetic messages can seem truthful if they are constantly replicated, frequently visible, and rarely critiqued (McGregor, 2019). If these narrowly defined representations of mathematics and the people who do well in it are internalized, it can be damaging to students' mathematics identity (Benoit, 2018; Benoit & Salopek, 2023).

In the same way discussions in mathematics classrooms can support students' understanding of the mathematical content (Michaels & O'Connor, 2015), we believe these discussions can support students in developing and sustaining expansive perceptions of mathematics and the people who enjoy it. By inviting students to select, share, and discuss mathematical memes, students are strengthening their critical mathematics media literacy and making meaning of the dominant, oppositional, and negotiated representations of mathematics (Kellner & Share, 2007). Opening space for students to discuss the societal narratives about mathematics they interact with every day, can help students negotiate their lived experiences with media artifacts (Alvermann et al., 2018).

The objective of these critical conversations is not to conform students to a teacher directed definition or a monolithic understanding about mathematics and its portrayal, though we do recognize the teacher's perspectives and actions have historically carried a great deal of weight (Behar-Horenstein et al., 1996; Gardee & Brodie, 2022). Rather, these conversations attempt to expand any limiting definition of mathematics and the people who "can" do it. In such discussions, students are the experts because they have the immediate and direct experience with popular culture (Appelbaum, 1995; Morrell, 2002). This means educators must learn how to relinquish authority and allow students to help facilitate classroom conversations. In turn, it gives educators of today an opportunity to "become more cognizant of ongoing popular culture curriculum and comprehend the relevance of public and professional discourse of mathematics education as an ongoing practice in and out of school" (Appelbaum, 1995, p. 46), a perspective later echoed by Bini et al. (2020).

Below we detail a mathematical task that was used as part of a research project to promote critical conversations about mathematics. Researchers Benoit and Salopek worked with students of teachers in their professional network to facilitate the task. Researcher Benoit conducted the activity with conversations while researcher Salopek observed with recorded notes. In particular, the researchers worked with Ms. Stanlee, a second year Caucasian-American mathematics teacher at Wakanda High School, a Brooklyn, NY public high school where 91% of the student population is Black or Hispanic. All pseudonyms for names and locations were inspired by students and reference Marvel's *Black Panther* movie. Conversations were held during the beginning months of the year, and were recorded and transcribed for further analysis using grounded theory methodology. Out of nineteen students, we chose to focus this article on four student examples that centered critical conversations about mathematics: Riri, an African-American female tenth-grade student, Shuri, an African-American female twelfth-grade student, Okoye, an African-American female tenth-grade student and M'Baku, a Hispanic male tenth-grade student.

Task: What Does This "Meme" to You?

This task asked students to submit artifacts – Internet memes or graphics interchange format (GIFs) – about mathematics that they engaged with on social media or the Internet. It served as a window into societal discourse about mathematics and gave a chance to explore student perceptions about the nature of mathematics. These social media artifacts were used by researcher Benoit to stimulate a semi-structured critical discussion about mathematics where students openly reflected on their and their peers' authentic thoughts about mathematical stereotypes, curiosities, or uncertainties as they relate to the selected and presented memes. Questions used to drive conversation were inspired by the Critical Media Project (https://criticalmediaproject.org/) as shown in Table 1.

Table 1

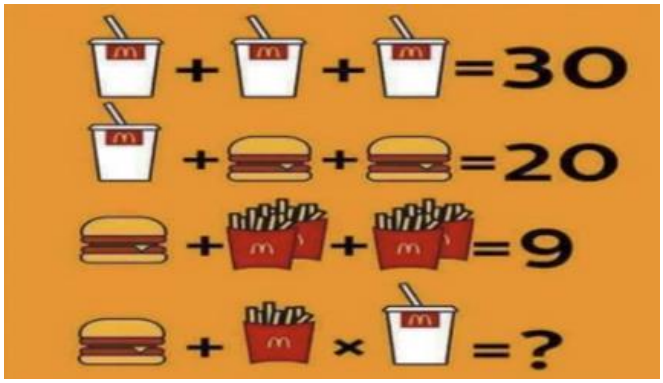
Potential Semi-Structured Discussion Questions

Questions
What message(s) is displayed in your social media artifact?
Do you agree or disagree? Why?
How might other people understand this message differently than you?
Would you share this message on your social media account? Why or why not?
Have you seen other artifacts with similar message(s)?
Who would create an artifact like this one?

"Answers to these memes are tricky" – Riri's Content-Specific Meme

Riri began sharing a mathematics problem within a meme (Figure 1). Riri stated, "there are these like little math quizzes, it's like a McDonald's fry, and then a cup, and they ask—can someone help me figure this out?" Riri, talked about how these mathematics problem memes go viral quickly because, "people start arguing and debating over the answer." Riri continued to suggest that there were lots of different answers posted in the comment sections and described how invested online users were to figure out the answer. Ironically, as Riri was discussing her meme, students were simultaneously shouting out potential answers, further demonstrating Riri's point. Riri continued to explain, "answers to these memes are tricky; the mathematical problems themselves are simple but if you mess up, that answer is a choice."

Figure 1
Riri's Meme



In other words, having multiple answer selections that are aligned to multiple procedural misconceptions and mistakes raises students' indecisiveness. Students indicated that memes like this usually go viral as multiple online users are willing to engage and share. Students pointed out the comments are the most entertaining part, as users passionately argue to get their point across. Further, all students, even those who do not regularly participate in mathematics class, indicated they engage with such memes in virtual spaces (Schifman, 2013; Bini et al., 2020). Four students submitted a mathematics content specific meme (i.e., system of equations, order of operations, logic) that were also discussed but not in as much detail. One thing to note is that examples like this illustrate how mathematical content transforms school walls into popular culture, creating and defining new mathematical spaces where multiple people are engaging with the content and are so passionate that debates ensue.

Students during these conversations have the space to discuss, comment, question, editorialize through the images and messages shared - push against hegemonic culture in mathematics - not just accepting what is told but letting students explore and discover for themselves. Mathematical memes can be the catalyst for mathematical ideas to be elicited and for future research on the educational potential of these memes since these encounters can be observed (Bini et al., 2020). Implicitly, her meme expanded traditional notions of mathematics, enabling a wide audience (going viral) to grapple with complex mathematics (three variable systems of equations) while explaining, defending, and critiquing their mathematical reasoning. Here, mathematics is seen as accessible, engaging, and fun, and not simply sets of problems to solve.

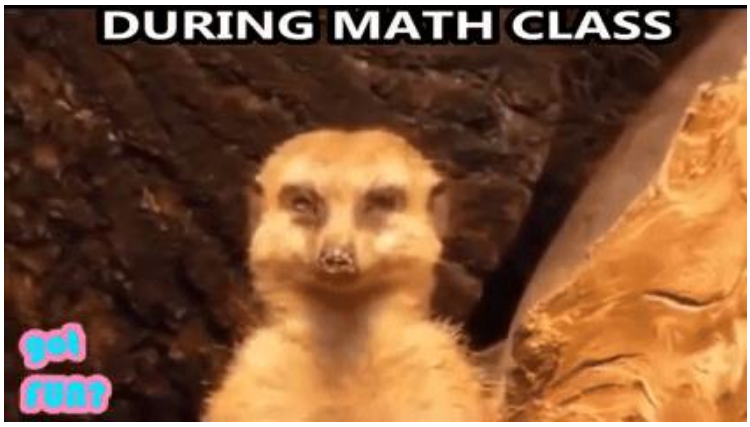
"Math being boring is not a secret" – Shuri's GIF, Instructional Suggestions

Shuri, presenting the GIF in Figure 2, began:

> Little lemur cats were pretending to be in math class. And some math teacher was like, 'If 4 equals *x* then we put *x* into the equation…' and one lemur cat is falling asleep because he's getting bored in the class.

Following Shuri's introduction, the class held an open discussion, where students had some initial time to make sense and interpret the GIF individually. Shuri began the discussion stating the message being portrayed is that "math is boring, and people struggle to stay awake. It implies that there is little interest in math." When probed further for other embedded messages, students collectively responded that they agreed with Shuri's interpretation of the meme. Most of the class articulated that they would share this on their social media accounts because "math being boring is not a secret," said W'Kabi. Shuri added, "Yeah, but it can also be an outlet for some that also feel math is boring, it could be relatable to other students." Shuri was expressing that memes can help validate students' feelings.

Figure 2
Shuri's GIF



As we continued talking, one important distinction became clear, students were saying the way mathematics was taught was boring, not mathematics itself. Students

expressed that mathematics should not be a lecture-based class (as illustrated in the GIF) but instead involve more student inquiry and exploration. "We should be doing things that are hands-on and figuring things out," said Nakia. Students seemed to be in favor of project-based mathematics where theoretical and abstract algorithms come to life as practical uses. The class was then asked who the creator of an artifact like this would be. Nakia responded, "this message was most likely created by students who clearly think mathematics is boring." Additionally, students were asked, "Which points of view were not represented in or omitted from this GIF?" Okoye expressed, "There are people who potentially enjoy math class." Shuri added, "Yeah people like yourself (Ms. Stanlee) and other mathematics professors and teachers. The GIF only represents the point of view of someone who shows a clear disconnection from the lecture. There are others who like math and prefer lectures." This example highlights our ability to see multiple perceptions and perspectives of mathematical artifacts, as they can be interpreted in a multiplicity of ways. Together we searched for alternative meanings and counter-narratives which helped us demonstrate that more than one perspective can simultaneously be true. While memes may have been created with an intended purpose and message, users ultimately have power to interpret messages the way they would like.

"We're gonna need to use it when we're older" - Okoye's Call of Significance

Figure 3
Okoye's Meme

As the conversation reached a lull, Okoye inserted Figure 3 into the discussion and shared, "There's ones like this, that show like a math problem and then they put it on the speed sign or stop sign. It was like they think this is how math is in life. Like you know, you need to solve it for everything." As the class laughed, Okoye was asked to further explain what she perceived the message to be. She explained, "teachers force it, they swear mathematics is everywhere." N'Jobu, added, "Yeah, that's what every teacher says. Like, we're gonna need to use it when we are older." Ramonda affirmed, "And sometimes they [students] will make fun of the way teachers say that we are going to need it for our life, but so many teachers have said it to us that we just take it as a joke now." From their commentary thus far, the meme questions the purpose of mathematics and is poking fun at teachers' overzealous ways of superficially promoting mathematics. Through the conversation, the students questioned not only the portrayals of mathematics in social media but also how mathematics teachers portray math as well. These particular critical conversations opened spaces for students to grapple with mathematics' relevance in their own lives.

N'Jobu then stated, "Yeah, like people say you need the Quadratic formula." Nakia followed, "Some people do need it; it depends on what you want." N'Jobu then claimed:

> Yeah, but most people don't need it when you think about it. All right, think about it, if you're working in a hospital. Then you would need it because you'll need to know the amount of medicine you put in, because you can put in the wrong amount and that person could die … But say you're doing clothing; you don't really need to know it, you're just designing something.

Namor interjected with an opposing thought, "nah, if you're rich you're going to need it 'cause you are going to need to know how to manage your money." The conversation grew silent and students did not come up with any alternative messages being portrayed. When asked who would create this meme, students said, "students making fun of teachers." While this meme shared some cultural views about mathematics teachers, about three-fourths of the class indicated they would post this meme on their social media accounts.

Though brief, this interaction between N'Jobu and Namor marks a moment in these students' lives where they interrogate the usefulness of mathematics as they contemplate real life applications. This will further be elaborated on in the discussion.

"Like we've been saying … math is hard" – M'Baku's Image, Effort and Cumulative Nature of Mathematics

As the class was ending, M'Baku quickly turned our attention to Figure 4 (his meme) containing Mr. Krab from SpongeBob Square Pants. M'Baku stated that everything is fine until someone says, math class is about to start. He and the class then began to laugh. When asked to clarify further, he suggested that the meme (indirectly) represents that mathematics is complicated and confusing. "Like we've been saying throughout this discussion, math is hard!" M'Baku asserted. M'Baku then explained:

> In eighth grade, I actually loved math. Like I found it so easy that all I had to do was just write it down. But now it's like, a lot more complicated and you have to use your memory and, like, ten different things.

When asked to say more, M'Baku acknowledged that he did not previously have to try and now he has to. He added, "Yeah, but before it was just like, do 20 questions really fast and you're done." He related his love for mathematics to the effort he had to exert. He stated that he previously loved mathematics because it was "easy" to him, and he applied little, if any, effort at one point. Mathematics is now requiring him to make more of an attempt, and consequently his love for mathematics is decreasing.

Figure 4
M'Baku's Meme

When asked if that was a bad thing, W'Kabi added, "Like, you just can't miss a day in geometry. You learn something every day." While the bell unfortunately cut the discussion shortly after, one thing to consider is W'Kabi's comments. In a class full of high school students belittling mathematics, we acknowledge W'Kabi could have easily said 'yes,' and presumably gotten laughs and admiration from his peers but he opted not to. Instead, he emphasized that effort is needed in mathematics learning and he conceptualized the cumulative nature of mathematics.

Discussion and Lessons Learned

Though this was just a snapshot of our conversation, memes offered students an accessible and familiar format to reflect, allowing them to be honest and vulnerable. Overall, students expressed their perspectives about mathematics, how it should be taught, its relevance (or lack thereof), as well as juxtaposed their experiences with mathematical discourse. While there were several notable takeaways, we focus this debrief on the four lines of discussion we deemed most helpful for others seeking to implement similar activities within their classrooms.

First, in Shuri's discussion, students identified the memes as relatable and something that parallels previous experiences. While the memes themselves may be created as a joke, or social commentary, these students saw clear cultural icons and connected the mathematics in the meme to their classroom experience. Furthermore, students demonstrated intentionality in their decision to share or not to share memes on social media. In other words, sharing memes can represent an intentional idea or attitude students may want to voice about mathematics; recognition of what that discourse is could be a telling artifact about their math identity. We must expand our discussion about Internet memes as solely humorous to potential ideological artifacts (Benoit & Salopek, 2023).

Second, mathematics content-specific memes seem to be an untapped resource in our classrooms. Recent research by Bini et al. (2020) found that mathematical memes create openings for collective meaning-making of mathematical ideas. Mathematical concepts and content are evident in our social realms and can be a powerful tool in connecting students' own daily experience to the content being explored in the classroom. This aligns to Appelbaum's (1995) suggestion that "teachers

can bring [memes] into their classrooms and utilize it as a tool to enrich, motivate, provide social context, and heighten the significance of mathematics" (p. 44), such has been the work of Bini et al. (2022), as they explore the creation and usefulness of meme templates for messaging in mathematics spaces. For example, Riri's meme was a cohesive blend of joy and content as students were drawn to solve it throughout the class. One possible extension could be to leverage the comments left on mathematical content-specific memes for mathematical exploration. For example, Riri's meme could be extended to say: Derek left a comment on this meme stating the answer is 60. Jennifer left a comment stating the answer is 25. Jacqueline stated they both were wrong but could not figure out where they made their mistake. Such questions get students to explain their reasoning, critique other answers as well as tease out common misconceptions, thus sources for error analysis that could be imposed into the mathematics curriculum. This is an opportune time to reinforce the nature of mathematics and who can do it; just because there are errors does not mean an individual is not a math person or cannot do math.

Third, though brief, M'Baku's comments were telling, in that the love of mathematics was inverse to the effort he was asked to put forth. This tension between effort and mathematical adoration aligns with previous research on mindsets (Haimovitz & Dweck, 2017; Hwang et al., 2019). The impression is that if you have the "ability," you should not need to try hard, and if you need to try hard, that is a sign that you do not have the ability. Ironically, he illustrates that mathematics identity can be fluid. Mathematics was "easy" and now it is "hard." Seeing identity as a collection of mathematical moments, whether good or bad, begins to help students reconceptualize who is allowed to do mathematics, pushing against the popular representations of "mathematician."

Finally, referring to Okoye's example (Figure 3), students want relevant and interesting applications of mathematics. While teachers continuously stress the importance of mathematics, students admittedly perceive it as mundane suggestions. Students are tired of hearing, "you are going to need it when you are older," and waiting for the arbitrary day when they will use it. Namor, like so many students, trivially identified managing money as a practical application of mathematics (Brenner, 1998; Yeo, 2010). Additionally, N'Jobu mentioned the need for hospital workers to be familiar with the quadratic formula (as a proxy for mathematics beyond arithmetic), while simultaneously suggesting that clothing designers may find the same concepts unnecessary. With regard to the quadratic formula, specifically, we find it far more likely a clothing designer would implement this mathematical concept, as compared to a hospital worker (Bakan, 2000). This does highlight, though, that advanced mathematics is deemed necessary for some careers (e.g., doctor, nurse) but not used in other careers (e.g., clothing designer).

While we feel as though the life and death sentiment was used to signify the importance of mathematics, such trivial examples like Namor's or extreme examples like N'Jobu's illustrate an ambivalence for mathematics application. Researchers such as Skovsmose (2013) have noted that some mathematical curricula lack the authenticity of "real" application. Skovsmose states:

> Applications of mathematics are difficult to observe and therefore to express an opinion on ... When the children fail to realize that mathematics is in action, they don't have any chance to question their opinions about it. When they do not realize that they are using mathematics, their image of the subject as belonging only to a textbook is not challenged (p. 96).

Taking the time, within a classroom, to explicitly create space for students to locate, introduce, and explore mathematics with memes allows for a larger conversation about what mathematics is, how it can be represented, and who can do mathematics. The students discussed in the above vignettes were given precisely that opportunity, allowing them to express opinions about who the likely meme creator was, in which jobs the mathematics may be more complex, and how "easier" mathematics may be more enjoyable. Without this experience, our students at Wakanda High perhaps would have been left to study mathematics through the lens of another, not for themselves.

Facilitation Considerations

As teachers are interested in getting to know their students, consider how memes can be used in the classroom to open dialogue about mathematics and students as doers of mathematics. This flexible and versatile task honors creativity and playfulness rather than simply answering questions about their previous mathematical experiences. This task is relatively

uncomplicated and straightforward to facilitate and can be revisited multiple times throughout the year, such as intermediate tasks when students are going on or returning from school breaks. Further, student-generated memes can be good formative assessments and allow teachers to examine the shifts students are making about their perceptions of mathematics.

The discussions can be arranged in several fashions depending on classroom size and time constraints. It could be facilitated as gallery walks, group discussions, or individual presentations depending on the teacher's desired goal. Additionally, as you read, we are sure you noticed some missed moments, where deeper follow-up questions could have been asked to elicit more student thinking. For this facilitation, we erred on the side of hearing many students, but moving forward we suggest selecting a few students and going into depth. These discussions also involve a great deal of vulnerability and trust as you are inviting the whole student into the mathematics classroom. As students share their raw, authentic thoughts, we urge for care and compassion to keep the critical conversations a safe space. As the year continues, teachers can have ongoing critical conversations about mathematics that challenge limiting mathematical associations, possibly helping students construct alternative ideas and reimagine their experiences moving forward. Additionally, while the ensuing discussion is taking place, teachers can make notes illuminating thoughts and messages, and examine how their routines and procedures support or challenge their notes.

Conclusion

We offer this task to be critiqued, modified, and iterated, as a support for students' and teachers' reflective practice to engage in ideological questions around social media and mathematics. Today, youth are everyday consumers of social media with routine access and availability to memes containing messages about mathematics. While we believe that young people are not gullible and have the capacity to practice discernment, we also believe that there is an opportunity to activate students' critical lenses and sharpen their attunements to mathematical values, stereotypes, and who is creating these messages. Each of these images come with layers of meaning – some meaning only unlocked through discussion with others, where multiple perspectives can be voiced. Students can become critical consumers about the messages they encounter and hopefully assist each other in constructing positions they may personally occupy (Alvermann et al., 2018; Morge, 2007).

Teachers have a role to play in these conversations. While the adults in these conversations help students build understanding about the messages presented and how they relate to the world of mathematics (both in and out of the classroom), they can also gather much needed information about how imposed routines and procedures can shift to better engage and support these learners. It is, therefore, not enough to explore the thoughts and feelings of only students who identify, present, and discuss mathematical memes. Studies focused on parents, teachers, and pre-service teachers are also needed. These new investigations would lead to a more complete understanding of the ways mathematical memes can and should be utilized to counter popular mathematical tropes (e.g., "math is hard," "only smart people do math") and deepen mathematical understanding and appreciation. As Gutiérrez (2013, p. 2) stated, "Not attending to identity and power means we are at best fooling ourselves about future prospects and at worst likely to ensure that mathematics education will be unable to realize its full potential for the 21st century." Normalizing critical conversations about mathematics, utilizing student selected mathematical memes, can be a step in the right direction.

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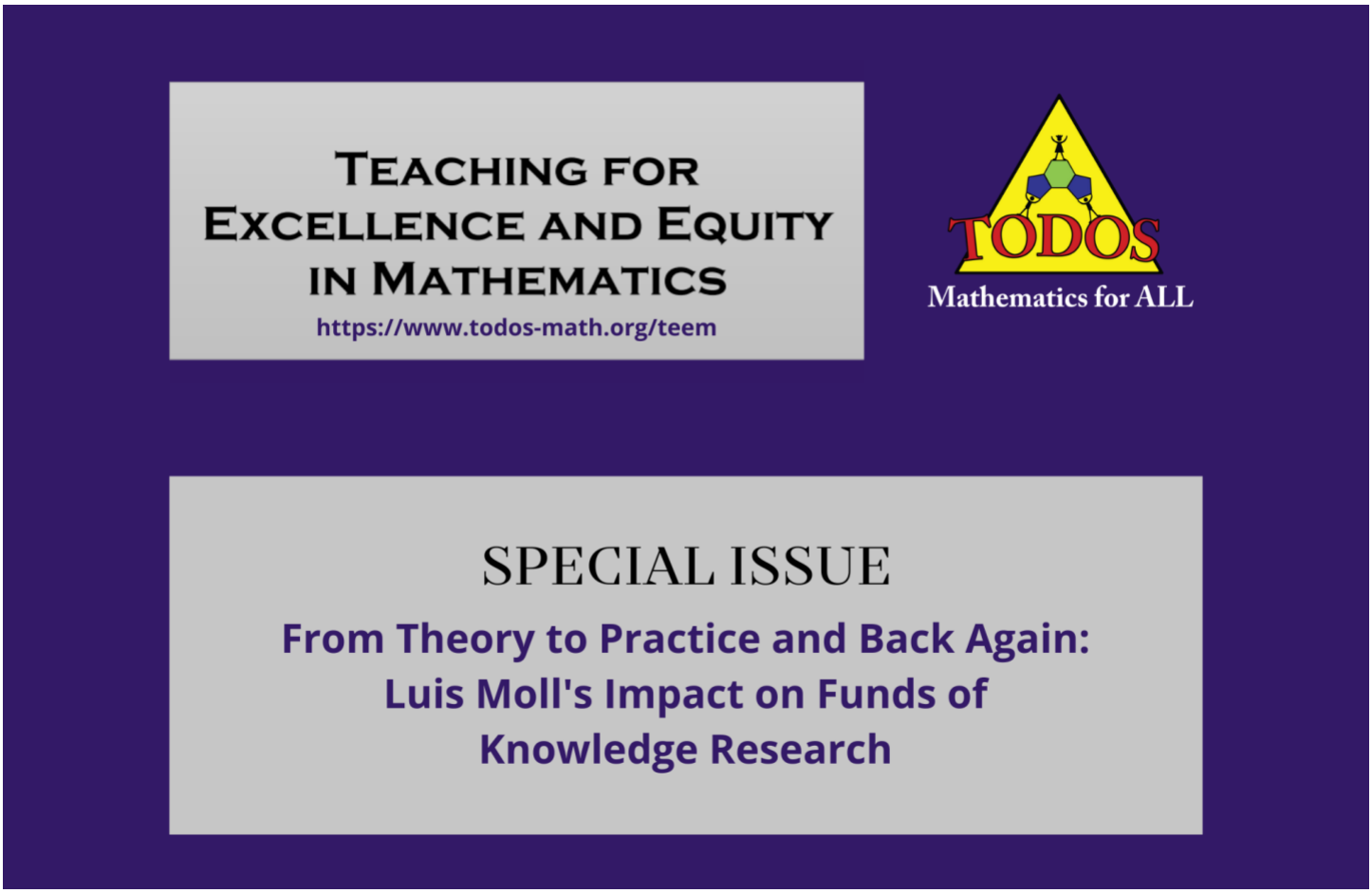
Discussion And Reflection Enhancement (DARE) Post-Reading Questions

1. What messages are students receiving about mathematics from popular culture? How do you know?

2. Attached is a link to our website https://mathmemeteam.com/ where we have designed three research activities (Coding Memes, Sharing Memes, and Submitting Memes), as well as educational resources to support educators in facilitating discussions within their own environment. What is helpful from these resources? What is missing that you wish was there?

3. When and how often will it be beneficial to explore the mathematical messages students are receiving about mathematics from popular culture?



***TEEM* Special Issue to Be Published in 2026!**

Mathematics Teacher Leaders' Responses to Equity in Turbulent Times

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Abstract

Historically, the task of reforming the political, economic, social, and culture systems that maintain White dominance and non-White subjugation has fallen on BIPOC communities. However, justice means that those who are from the dominant White class–those who are in positions of power–need to "sweep outside" their own front door and take action to disrupt these inequitable systems. In this article, we aim to show how K–12 mathematics teacher leaders and district leaders use their power to respond to equity. Drawing on a larger set of K–12 mathematics teacher leader interviews, we used poetic transcription to emphasize their noticings related to social unrest during the first year of the COVID-19 pandemic. Reflecting the demographics of educators in the U.S., all participants were White and thus their reflections provide insight into how White educators in power may respond to inequity, including the tensions they grapple with and the ways they choose (or do not choose) to move beyond inaction. Our findings suggest that district leaders and teacher leaders can exercise their power to challenge systems of oppression pervasive in mathematics education, particularly by addressing their peers' deficit thinking toward students and in eliminating systems of tracking.

Discussion And Reflection Enhancement (DARE) Pre-Reading Questions

1. What challenges do teachers face in trying to make their classrooms and districts more equitable for mathematics teaching and learning?

2. When people talk about "closing equity gaps" or use phrases such as "high student" or "low student," what do they mean? How do you respond?

3. How did the 2020 dual pandemics of COVID-19 and racial violence influence your school/district/institution's discussions of equity?

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[1] Quaisley's and Funk's contributions to this manuscript were comparable, and as such should be considered co-first authors. All authors contributed significantly to the data analysis and writing of this manuscript.

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Mathematics Teacher and District Leaders' Responses to Equity in Turbulent Times

Kelsey Quaisley, Rachel Funk, and Wendy Smith

Introduction and Purpose

This work exists within the context of the United States of America (U.S.), which has a long historical record of White supremacy enabled explicitly and implicitly by multiple systems (e.g., housing, healthcare, legal, education). Historically, the work to change these systems has been spearheaded by those who have been oppressed by these systems. But it is unjust for BIPOC (Black, Indigenous, People of Color) communities to shoulder the full burden of equity work. White folx need to be responsible activists who hold systems and themselves accountable for historical harm. Specifically, White people who engage in racial justice efforts need to stop focusing on saving People of Color, and instead focus on themselves:

> White folx who do the work of racial justice need to get their people because Black folx are tired. And it's not our job to save White people from Whiteness…as Patty would say, 'sweep outside your own front door.'...White people need to stop trying to save Black people; instead, they need to focus on saving themselves. Black people don't need saving. We need the removal of the institutional barriers that prevent, stop, and aim to kill Black progress, Black freedom, and Black joy. We need White people to love themselves--enough to let go of their need for power and conquest that is killing them and their children, enough to stand up to the super predators who tell them lies to keep all of us oppressed, and enough to take responsibility for their community. (Love, 2023, pp. 240-241).

For White people, taking responsibility necessitates being vulnerable, emotionally and epistemically, to the reality of one's own privilege in society (Applebaum, 2017; Gilson, 2011). Such responsibility involves being vulnerable and empathetic to the experiences of those who have been marginalized, being open to changing one's beliefs, and having the courage to take action to subvert cultural norms and structures that uphold inequity. But those in positions of power can find it challenging to be this vulnerable. DiAngelo (2018) introduced the notion of "White fragility" to describe the defensiveness that White individuals typically display when confronted with evidence of racism. Furthermore, White individuals who acknowledge systemic inequities often position themselves as powerless to disrupt these inequities (Dancy & Hodari, 2023). In one study, Dancy and Hodari (2023) interviewed 27 White men in physics who expressed an interest in equity but took no action to dismantle their own privilege. As scholars, we are interested in knowing how to support White people and other people in positions of privilege to move beyond guilt and into action to disrupt inequities in education (DiAngelo, 2018).

Gutiérrez (2009) notes that "equity is ultimately about the distribution of power" (p. 5). Teacher leaders are key power brokers in education, and predominately White. Thus, teacher leaders are well positioned to engage in equity work, but this work requires that they confront White fragility and their discomfort to move towards action. Research has shown the potential for teacher leaders to support equity in schools (e.g., Jacobs et al., 2014). Even though little has been published about research on mathematics teacher leaders' impacts on school equity (Baker et al., 2024), a body of research focuses on individual teachers' efforts to enact equity or social justice in their classrooms (e.g., Gutstein, 2016).

In this study, we share a poetic analysis of the emotions and actions displayed by leaders in mathematics education in response to the inequities that the COVID-19 pandemic helped to illuminate. Notably, the final draft of this paper was

written in 2025 as attacks on equity work are accelerating within the U.S. Although such efforts have always been under attack, the level and scope of these attacks is significant and likely to get worse. Effectively addressing systemic attacks requires the work of White allies and the marginalized communities under attack; White allies must ensure they are approaching the work in a humanizing and authentic way, not swooping in as "White saviors" but instead listening to needs and using power and privilege to help leverage common solutions.

In this paper, we aim to show how teachers and district leaders—all coming from relative positions of power—challenge systems of oppression, i.e., "sweep outside [their] own front door[s]." (Love, 2023, p. 240). We center the voices of teachers and district leaders who reflect on the critical axis (Gutiérrez, 2012) in their work to support equitable mathematics learning (Cintron et al., 2021). Further, we showcase how they respond to systemic inequities in their school systems as a means of generating further discussion and understanding of the tensions they grapple with and ways they feel empowered to move beyond inaction.

Although we focus on teachers' and district leaders' responses, we highlight the ways in which they attended to and interpreted the broader social contexts of their work, including how the pandemic and social unrest have differentially impacted students, their families, educators, and communities due to racial and socioeconomic dynamics. DeBray et al. (2023) note the differential impacts of the pandemic and implications of educational policy: "Education policy must address the toll of the pandemic on our educational system broadly, as well as the racial and socioeconomic segregation that exacerbated the impact of the pandemic on students, educators, and the overarching system" (pp. 4-5). Just as broader social contexts are vital to education policy, broader social contexts are also vital to teacher leaders' responses to equity. We expand the literature on mathematics teacher leaders' impacts on equity by investigating and expressing teacher leaders' responses toward issues of equity arising from (and highlighted by) the COVID-19 pandemic and the social unrest surrounding the death of George Floyd, among others. To this end, we explore:

> *How did mathematics teacher leaders and district leaders respond to concerns surrounding equity within the dominant and critical axes of equity (Gutiérrez, 2012) during a global pandemic and social unrest?*

Collective Positionality

We are three White women with varied experience in mathematics teaching and education research. We value collaboration, conversation, dialogue, and emotion. These values guide how we teach, how we work together, and the research methods we choose. In our teaching and our research, we aim to understand, humanize, and question with curious criticality the perspectives held by students, participants, and ourselves. All three of us have taught mathematics at the tertiary level, and one was a secondary teacher leader. We all have experience facilitating conversations about equity and racial literacy in education settings, and in advocating for critical changes to mathematics education. We have worked extensively with prospective and practicing teachers of mathematics, instructors, and faculty members to challenge traditional, dominant educational structures. This has included workshops (e.g., in which we collectively learn about and reflect upon White supremacy culture in our work) and multi-year partnerships in which we explore data and its use in equity work.

In our teaching and in our research, we seek opportunities to reflect critically on our social and professional positioning in society broadly, and mathematics specifically. We feel it is important to ask who benefits from what we share and who has a voice (or is silenced) (Idahosa & Bradbury, 2020; Liamputtong, 2007; Smith, 2012). In prior work, we have endeavored to better understand the experiences of postsecondary mathematics instructors and mathematics teacher educators engaging in equity work, many of whom benefitted from dominant mathematics culture, in hopes of understanding what might move instructors to be vulnerable and critically reflexive in their practice, and ultimately to take action for equity (Anderson et al., 2022; Funk et al., 2025; Hagman et al., 2025). We hope that this study similarly gives teachers an opportunity to reflect critically on what their role could and should be to advance equity.

We recognize that the majority of the teacher workforce is White. By describing the experiences of White teachers responding to equity, we are not aiming to minimize or make invisible BIPOC voices, nor are we showcasing White teacher leaders as saviors of BIPOC students. Rather, we aim to evoke emotion and reflection by sharing how White teacher leaders aspire or fail to use their power responsibly in consideration of the experiences of BIPOC individuals. We specifically focus

on participants' responses during the 2020 pandemic. Although we use the "dual pandemics" of COVID-19 and racial violence (Jones, 2021) as the focus of this work, we recognize that for BIPOC communities, racial violence has been an ongoing phenomenon and not just a recent crisis. However, 2020 brought additional awareness of racial violence and inequities built into our society, prompting overdue conversations within and beyond education about our roles in addressing system changes.

Teacher Leadership and Equity

In their review of the literature on teacher leadership, Wenner and Campbell (2017) note a dearth of literature about social justice, equity, and teacher leadership, as well as a lack of researchers defining what they mean by *teacher leaders*. Our conceptualization of teacher leadership is based on Criswell et al. (2018): "a teacher leader must assist those operating at different levels of the system to see practices in ways that will allow them to make sense of innovations and doing this [sic] in a manner that is collegial and not controlling" (p. 832), along with Criswell et al.'s conception of "*teacher leader as reflective practitioner*" (p. 816, italics in original). We also add Harris's (2003) suggestions that "leadership is part of the interactive process of sense-making and creation of meaning that is continuously engaged in by organisational members … Leadership is about learning together and constructing meaning and knowledge collectively and collaboratively" (p. 314). This view of leadership is echoed by Bowman et al. (2004):

> Education leaders guide their colleagues by engaging in collective conversations, invoking symbolic gestures that reveal relationship, modeling professionalism beyond the label of one's role, championing evocative ideas in both the classroom and the workplace, and being "in influence" as opposed to being "in control." (p. 188)

Further, we employ a broader categorization of teacher leaders than some others in the literature (e.g., Wenner & Campbell, 2017; York-Barr & Duke, 2004) by including both PK–12 classroom teachers with formal or informal leadership roles and PK–12 professionals (including math coaches and district mathematics supervisors) who directly support teachers.

Teacher leaders have the potential to become key change agents in creating and sustaining more equitable schools (Criswell et al., 2018; Jacobs, Beck, & Crowell, 2014; Milner IV et al., 2015). COVID-19 and concurrent racial turmoil have generated opportunities for educators to center equity and antiracism in education spaces (Fletcher, 2023; Mincu & Granata, 2021). The U.S. Department of Education called for school systems to respond to the pandemic with a focus on equity:

> We have a rare moment as a country to take stock and to begin the hard work of building our schools back better and stronger—with the resolve necessary to ensure that our nation's schools are defined not by disparities but by equity and opportunity for all students. (U.S. Dept. of Education, Office for Civil Rights [2021] in response to Biden's Executive Order 14000 during the COVID-19 pandemic)

We sought to understand how teacher leaders conceptualized equity and their own agency in impacting equitable mathematics teaching and learning. These conceptualizations are grounded in literature (e.g., Gutiérrez, 2012) but applied in the real contexts of post-2020 school systems.

Mathematics as "Neutral" Narrative and Conceptualizing Equity in Mathematics Education

Mathematics is an inherently social, cultural, and political practice. However, the dominant narrative in our society is that mathematics is neutral or removed from social, cultural and political spheres (Lue & O'Neal Turner, 2020; Martin, 2013). This "math is neutral" narrative is a function of Whiteness (Gutiérrez, 2017; Martin, 2013; Rubel & McCloskey, 2019). Gutiérrez (2017) describes myriad ways in which mathematics, and specifically mathematics teaching, upholds Whiteness in our society: from curricula that emphasize Eurocentric mathematics to the widely held belief that mathematical ability is an innate, fixed proxy for intelligence (and thus superiority). She argues that these narratives are tacitly transmitted in the teaching of mathematics; therefore, "mathematics teaching is a highly political activity" (p. 18). Mathematics teachers play a key role in how students experience mathematics. Teachers' conceptions of equity and intentions to center equity (or not) in their activities have broad implications. Those engaging in equity work must develop knowledge that allows them to

navigate and interrogate existing structures, such as high-stakes testing or student tracking, in coordination with others for the purpose of reimagining or reinventing such structures (Gutiérrez, 2017). Mathematics teacher leaders, specifically, are key power brokers in education. Thus, they are uniquely positioned to engage in equity work.

There are many ways to conceptualize equity in mathematics education (Vithal et al., 2023). We ground our study in Gutiérrez's (2002, 2009, 2012) framework that considers equity along two major axes (dominant and critical) with four major dimensions (access, achievement, identity, and power). *Access* is related to students having sufficient resources available to support their learning of mathematics and participation in school. *Achievement* is the dimension most commonly used to measure equity, often using test scores to document student understanding and mastery of mathematics learning objectives. As others have documented, focusing on achievement gaps can reinforce deficit views of BIPOC students (Martin, 2013). Access and achievement lie on the dominant axis of equity (as they are the primary focus of dominant reform efforts). However, mathematics education needs to focus on the critical axis of equity just as much, if not more, than the dominant axis of equity. The critical axis of equity contains two components (*identity* and *power*). *Identity* is broadly about students' identities, both inside and outside the mathematics classroom, and how students' identities and their perceived social markers impact their learning experiences. This component includes mathematical identity, which is inextricably connected with an individual's identities inside and outside of the classroom (Lue & O'Neal Turner, 2020, p. 144). *Power* looks at whose voices are heard in the classroom, whose ideas are elevated, who decides what counts as knowledge and understanding, and students' empowerment to use mathematics toward social justice aims.

Responding to Equity

Similar to LaTona-Tequida et al. (2022), we draw from the work of professional noticing (Jacobs et al., 2010) to capture teacher leaders' noticing of equity in relation to students' mathematical access, achievement, identity, and power (Gutiérrez, 2009, 2012). We use the Attend-Interpret-Respond (AIR) framework (Jacobs et al., 2010) to conceptualize three ways in which teacher leaders may notice equity-related concerns. First, teacher leaders' *attention* is characterized by judgment-free observations about students' mathematical access, achievement, identity, and power within and across multiple layers of the educational system. Second, teacher leaders' *interpretations* are characterized by their judgments and explanations of the observations to which they have attended. Third, teacher leaders' *responses* are characterized by their specific actions to address equity-related concerns.

Methods

Inequity in mathematics education is a critical global problem (Vithal et al., 2023), and thus a crucial focus of inquiry. Critical qualitative methods are necessary to capture the nuances of the complex issues of equity in education, how educators and students navigate those complexities, and how these issues are inextricably linked with the identities of those involved (Vithal et al., 2023). Use of poetry to explore such complex issues can lead to deeper understandings of transformational mathematics teaching (Martinez et al., 2023).

Poetic transcription is a qualitative, critical research method used to represent the voiced experiences of participants (Glesne, 1997; Illingworth, 2022). It has roots in found poetry, "a process which takes existing texts and re-mixes their content to create original pieces of poetry" (Illingworth, 2022, p. 81). Researchers have used poetry in multiple ways although the "best" poetic inquiry focuses on experiences within an affective, experiential domain (Prendergast, 2009, p. 546). Poetry can convey not only ideas and concepts but also emotions. More traditional data analysis techniques are often designed to extract facts, not necessarily to convey the salient emotions of the participants. However, when considering issues of racial equity and the role of the education systems in perpetuating versus challenging inequities, emotion plays a role in the reactions and decisions of the people involved. Thus, poetic transcription has the potential to illuminate the experiences of teacher leaders and district leaders in authentic ways that help researchers, and teachers themselves, understand their complex and messy experiences, in turn advancing equity in mathematics education, particularly along the critical axis.

In this study, we used poetic transcription as part of a secondary analysis of semi-structured interviews with 18 Nebraskan mathematics teacher leaders and district leaders from November 2020 to January 2021, at the height of the COVID-19 pandemic. All participants either worked as full-time teachers or in leadership roles outside of the classroom (e.g., math coach, district math coordinator). One clear limitation to our study focused on racial equity is that none of our participants identified as racially marginalized although we want to emphasize that equity work is the responsibility of all of us, not just those with minoritized identities. Further, the teacher workforce in Nebraska has remained approximately 95% White since such data were made publicly available in 2005, so the problematic lack of racial diversity in our study reflects the problematic lack of racial diversity in Nebraska's teacher workforce in contrast to the 38% BIPOC student population. We centered our findings around those leaders whose interviews described a response to equity (beyond simply attending or interpreting) along both the dominant and critical axes of equity.

This study is part of a larger Noyce Track 4 project (Yow et al., 2021) studying K–12 STEM teacher leadership. Although the interview questions were oriented around a number of leadership-related concepts, we focused our analysis on the interview questions about how leaders experienced inequities and worked toward more equitable school systems. We extracted responses to these questions, as well as other mentions of equity in the interviews, and independently coded the responses using Gutiérrez's Dimensions of Equity (Gutiérrez, 2012) and the AIR framework (Jacobs et al., 2010). We then met to reconcile these codes. From this analysis, we identified four teacher leaders and district leaders who responded to equity in ways that emphasized both the dominant and critical axes of Gutiérrez's framework (See Tables 1 and 2; names included are pseudonyms. Names beginning with "T" represent full-time teachers and names beginning with "D" represent district leaders. Note that Teagan and Dune identify as White women, and Terran and Dawn identify as White men) The other 14 educators either did not address the critical axis of Gutiérrez's framework or did not discuss responses to equity (instead only focusing on attending to or interpreting contexts involving equity). Because we wanted to highlight educators' responses or actions beyond the dominant axis of Gutiérrez's framework, we chose to highlight the reactions from these four leaders. Using the coded segments from the four leaders, we conducted an additional open thematic analysis to develop themes about equity and noticing. In the process we paid particular attention to what teachers felt was equitable/inequitable (e.g., structures, cultural ways of doing) and the emotions they felt or actions they described taking in response to these inequities. Three themes that stood out included tracking, combating deficit perspectives, and teacher agency. We then crafted collective poems via poetic transcription, juxtaposing segments from different interviews to form a type of conversation around responses to systems of oppression. Through this poetic format, we invite readers into conversation about the reality and perceptions of well-intentioned White educators grappling with inequities in education.

To poetically transcribe the data, we each individually read through the coded segments and extracted words or phrases that could convey the meanings of each segment. We then (separately) crafted these words and phrases into poetic stanzas for each teacher leader. Next, we met and shared our poems with each other, then collectively created a combined poem (Figure 1) via many iterations that featured stanzas from our individual poems, new stanzas, and combined stanzas. We also arranged the stanzas in a coherent order that conveyed the major themes we identified. We used boldface text to draw attention to unjust or inequitable systems or structures identified by teachers, italics to convey dialogue recounted by teachers, uppercase to emphasize emotional drivers for change, and indentation for teachers' responses to (in)equities.

Symbolically, we felt that boldface offered a means to make more visible the inequitable systems that are often described as invisible. Similarly, we felt that uppercase words both attracted visual attention and strengthened the weight of an emotion, e.g., we felt that "EMPOWER" more strongly communicated boldness and resistance—we aspired to evoke the emotions of a protester holding up a sign written in uppercase, shouting at a demonstration. Lastly, we chose italics in dialogue as a typical means of communicating the leaders' verbatim speech, and indentation as a way to set apart these leaders' actions as distinct steps forward. As an example of our collective poetic transcription process, all of us included the "ripping off the band aid" excerpt as a clear teacher leader response, but in different positions. As another example of our collective poetic transcription process, one author included a stanza about teacher agency—"Shifting to hybrid - some teachers regressed / to less than ideal instructional practices / But they don't have a choice right now." We ultimately decided not to include that stanza in the final poem because it did not have a clear context, such as particular injustices or inequitable structures. We also considered different formats for the poem, initially crafting themed sections to align with the equity and

noticing themes we coded; however, as we sought to combine different stanzas, we realized we could position them to be in dialogue with each other. Extracting evidence of actions using the AIR framework, we deliberately chose to end the poem with themes of hope and empowerment from teachers for students to reinforce our focus on leaders' responses to inequities. To engage in member-checking, we shared a draft of the manuscript with the four leaders to invite their reactions and actions. We also invited teachers to take part in the poem construction process although the timing did not work out for them to participate. All four participants provided feedback on the manuscript, including the poem. One participant expressed discomfort with the positioning of one of the stanzas, crafted from their interview, because its positioning relative to others connoted an emphasis on race more than they originally intended. Accordingly, we moved the stanza and shared the revised poem with the participant; they were satisfied with the revised version of the poem.

Table 1

Code Frequencies by Gutiérrez's Dimensions of Equity

Participant	Access	Achievement	Identity	Power
Terran	3	2	1	0
Teagan	4	3	1	3
Dune	2	4	1	0
Dawn	2	0	1	2
Other 14 Participants	24	9	8	0
Total	**35**	**18**	**12**	**5**

Table 2

Intersection of AIR Framework and Gutiérrez's Dimensions of Equity for Selected Participants

	Access	Achievement	Identity	Power
Attend	Teagan Dune	Dune		Dawn
Interpret	Teagan Dune Dawn	Terran Teagan Dune	Dune	
Respond	Terran Teagan	Dune	Terran Teagan Dawn	Teagan Dawn

Findings: The Poem

In this work we sought to explore the central research question: How did mathematics teacher leaders and district leaders *respond* to concerns surrounding equity within the dominant and critical axes of equity during a global pandemic and social unrest? In Figure 1, we share the poem as our findings before reflecting on how the structure and content of the poem add nuance to multiple themes in our discussion section. These themes include combating systems of oppression in mathematics education, the drive for action versus mathematics educator agency and safety, hope and skepticism in mathematics education change efforts, and dominant and critical axes of equity in mathematics education.

Figure 1

Poetic Transcription of How Mathematics Teacher Leaders and District Leaders Responded to Concerns Surrounding Equity

Teacher Leader Teagan:
At a very young age we **track**.
we create the **haves** and the **have-nots**.
It's just horrible - why do we even need that?

District Leader Dune:
There are assumptions **students have gaps**
I was having a conversation with a teacher
*"Well, those are my **low students**. These kids can't do that"*
I just ripped the band aid off
I said: *"Do your kids know that you define them that way? How does that make them feel?"*

District Leader Dawn:
I need to be willing to PUSH on people
stop trying to go around to make changes
towards more equity
Just be very direct:
No, this is why we're doing this,
so stop doing that.

District Leader Dune:
We're still feeling like it's not safe to push
We've worked for years
to stamp out **tracking**
To stamp out **ability grouping**.
We've regressed . . . I guess we never really left it.

Teacher Leader Teagan:
I want sutdents to learn mathematics
through the lens of social justice.
Expose students to something they don't know exists
Looking at **mortgage denial rates based on race**
EMPOWER them to act
But in a district, you have to make sure everyone is okay with what you do:
Go through proper channels.
Include all stakeholders in district-level decisions.

Reading in the news of **teachers getting fired for including social justice in their class**:

I have wanted to take more action steps
for equity but haven't.

District Leader Dawn:
You know, **our school systems are designed for middle class White folks** to be successful

Teacher Leader Terran:
Suburban communities want to keep things the way they are.
They're comfortable. Their kids are successful.
Their test scores are great.

Policy swings back and forth,
placating political extremes
Yet the pendulum **pushes for career readiness.**
Predicting career trajectories
for the economically disadvantaged.
Making draconian choices about kids' futures.

District Leader Dawn:
This summer's uprisings opened up a lot of conversations around equitable school structures and instruction.
We gave it lip service before

But the conversation has shifted this year
"no, we really need to do something"
opened up some space
for a little more direct conversations
we're making some movement

We'll see if in a year or two
if it's still happening
but it gives me HOPE.

District Leader Dune:
We're not really into the grit of the equity conversation yet.
I hope we get there.
I hope that sticks around after the pandemic.

Teacher Leader Teagan:
My CHALLENGE to administration this year:
hear the stories of students
in our building
Then take action steps based on those.

Discussion

This poem shares the experiences of teacher leaders who have benefitted from the current system. Through our interviews with White teacher leaders and district leaders, we wanted to understand if and how they are acting as allies or seeking to disrupt dominant White supremacist traditions in education. Our poetic transcription reflects the tensions of White folx raised in a White supremacist culture trying to dismantle systems of oppressions (Love, 2023).

Some mathematics leaders felt a tension characteristic of White fragility—a desire for comfort contrasted with the discomfort of acting, e.g., "I need to be willing to push" contrasts with "we're still feeling like it's not safe to push"; "I have wanted to take more action steps / for equity but haven't." These tensions are connected to the desire to push against the mythical neutrality of mathematics (Gutiérrez, 2017; Lue & O'Neal Turner, 2020; Rubel & McCloskey, 2019). By focusing on actions (the *respond* part of the AIR framework), we were looking for how White mathematics leaders may have been working to dismantle systems of oppression in mathematics education.

Combating Systems of Oppression in Mathematics Education

The mathematics teachers and district leaders represented in our poem responded to mathematical (in)equity by challenging the status quo and racial or economic disparities upheld in their communities. Teagan described how teachers could use their power in the classroom to respond to systems of oppression. They described a desire to empower students through social justice mathematics lessons. Dune, a district leader, describes collaborative efforts to "stamp out" tracking and ability grouping in mathematics. We emphasized the conversation Dune recollected having with a teacher, in which they "ripped the band aid off," as a striking response to Teagan's question: "Why do we even need that [tracking]?" Using deficit language to describe students is symptomatic of as well as reinforces White supremacist narratives in mathematics (e.g., meritocracy, that mathematics ability is fixed). Thus, through their response Dune explicitly challenged this hegemony, even though they knew that doing so may have elicited an emotional (hurt) response from the teacher they challenged. Although we do not know the identity of the teacher they challenged, such a response by Dune suggests that they are willing to combat the White fragility of their peers in service of supporting students.

We also feel some tension in the ways in which some of these leaders may be understanding or challenging systems of oppression. Although Dawn and Terran called out White supremacy in education ("our school systems are designed for middle class White folks to be successful" / "Suburban communities want to keep things the way they are"), Dune explicitly did not want to position their words ("we're not really into the grit of the equity / conversation yet") around the stanzas calling out race and racism. Further, Dune elaborated that they do not feel that their peers are making deficit comments about "low students" based on race or gender identities. We wonder if this hesitancy is indicative of White discomfort; explicitly the desire to not appear as if they are calling out their peers as racist or sexist.

Drive for Action Versus Mathematics Educator Agency and Safety

In stanzas 3–5, we used the words of Dawn, Dune, and Teagan to form a dialogue of a prevailing tension between mathematics educators' drive to take action for equity and feeling a lack of agency or safety to do so. Mathematics educators engaged in this work feared consequences of their actions, such as losing their job or political backlash from their communities. These educators may want to do something—"I need to be willing to push" (Dawn)—but struggle with a collective feeling that "it's not safe to" (Dune). They may also feel a sense of defeat or frustration in their attempts to change dominant systems ("I guess we never really left it"; Dune). We structure this dialogue to showcase that this tension was felt by district leaders as well as teachers, albeit at different levels of influence on mathematics education. For Teagan, fear and incredulity, prompted by stories of teachers "getting fired" may have prevented them from responding to their desire to include more social justice topics in their classroom. Dune feels this tension either personally or collectively ("we're still feeling…"), which prevents the success of larger structural changes to mathematics education at the school or district level (e.g., attempts to stop tracking). Dawn recognizes that to take action for equity, they need to be less comfortable, more

courageous and more direct in conversations with others, rather than "trying to go around" to enact change in mathematics education.

Hope and Skepticism in Mathematics Education Change Efforts

Throughout the mathematics teacher and district leaders' interviews, we saw hope that equity work will continue beyond the dual pandemics of 2020, balanced with various degrees of skepticism. Changing education systems is hard, and any one teacher leader lacks sufficient power to change the broader educational system. The improvement work must be approached collectively. Dune hopes "we get there" but notes that "we're not really into the grit of the equity conversation yet." The hope is offset by noting how long the leaders in the district have been working to eliminate tracking and ability grouping in mathematics, and how quickly those inequitable structures returned during the dual pandemics, showing that "we never really left it." Dawn shared that the social unrest in 2020 opened up new conversations about equity that in the past had been given "lip service." Dawn commented that "the conversation has shifted this year… we'll see in a year or two if it's still happening, but it gives me hope." Change is often slow in education, but acknowledging that equity is a complex problem and having honest conversations about the problems and potential solutions are promising steps toward positive changes in mathematics education.

Dominant and Critical Axes of Equity in Mathematics

The poem's exchange between Dawn and Terran (in the second half) emphasizes the educators' awareness of the systemic complexities of equity and education—specifically, how the educational system is structured to maintain dominant Western ideologies that benefit White communities. Dawn calls attention to racism inherent in the design of the U.S. education system, and Terran calls out how focusing on achievement ("test scores") and economically driven motives perpetuates inequalities. We highlight Terran's response as an implicit damning of policies that follow an interest convergence (Bell, 1980) argument: Terran describes how a focus on "career readiness" (an economic imperative of the dominant society) "forces" draconian choices that impact economically disadvantaged students.

In order to change systemic inequities, we need to go beyond supporting students within the dominant system (e.g., improving their mathematics test scores, securing their economic well-being) to enacting courageous, imaginative, and critical changes. Such changes should foster a system which embraces people's identities and empowers those who have been marginalized to make changes that imbue power to those who have the least. In our analysis, two out of 18 participants had responses that we coded with power, showcasing that most responses did not address the power of students—particularly BIPOC students—in the educational system. However, given the importance of the critical axis to equity work, we emphasize these responses by including them in the poem. Teagan brings up issues of power in two substantial ways: they describe their desire to use mathematics curriculum as a way to empower students to take action for themselves, then issue a challenge to administration (those who may be viewed as the ones in power) to take action based on the stories as told by students. Centering educational decisions on the needs of students is not new (Dewey, 1902), but public schools in the U.S. are set up with structures that have little space for student stories. Looking at systemic improvement via the critical axis prompts us to take an anti-deficit stance that starts from students' identities and builds opportunities to learn based on students' strengths and goals; this type of stance demands creativity, empathy, and courage.

Conclusion

The discussions around and responses to inequities that we investigated echo similar themes in conversations about equity in other spaces (e.g., Lolkus et al., 2023). The U.S. educational system was indisputably founded in White supremacist culture, which still permeates the system and needs to be challenged. At the same time, equity is under attack at all levels of government: in 2025 (at the time this manuscript was submitted), the U.S. government terminated an overwhelming majority of educational initiatives that support historically marginalized communities (e.g., Mehta, 2025). These attacks, alongside long-standing racist educational structures and policies, contribute to the pressure teachers may feel to "keep

things the way they are," e.g., by engaging in performative "lip service" equity efforts or excluding social justice themes from mathematics lessons. Certainly, for White teachers, it is easier to maintain the status quo, where people can pretend mathematics is neutral and schools continue inequitably tracking students. But averting the inequities driven by our White supremacist culture does not lead to the improved mathematics teaching and learning necessary for all students to have equitable opportunities for potential careers. Rather, teachers must acknowledge these inequities and choose to be brave. But importantly, teacher leaders, district leaders, and those in higher positions of power should support this bravery. Equity work should not be done in isolation, but in community. Especially in environments where teachers face explicitly hostile policies, engaging in such work may need to take the form of creative insubordination (Gutiérrez, 2015).

As DiAngelo (2018) writes, "interrupting racism takes courage and intentionality" (p. 153). The mathematics leaders in this study have shown continued dedication to equity by learning to critique, challenge, and navigate inequitable systems in individual and structural ways, such as working to eliminate mathematical tracking of students. Courageously, these leaders have named and spoken up about the inequities within mathematics and broader educational contexts. Furthermore, these leaders have "ripped the band aid off" and are (cautiously) eager and optimistic about engaging in accountability for themselves and the systems in which they work. These mathematics teachers and leaders give us hope for the potential of mathematics teachers and leaders to engage in meaningful equity work. In addition, as we express with juxtaposition in the poem, district leaders and teacher leaders can work with teachers to center the critical axis of equity in combating systems of oppression, particularly by addressing deficit thinking toward students and in eliminating systems of tracking in mathematics. Advancing equity comes with risks, and we recognize that these risks are rising, but our society needs teachers and leaders with power to be courageous, creative, passionate, and dedicated to standing up against racist systems for the benefit of all students.

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Discussion And Reflection Enhancement (DARE) Post-Reading Questions

1. How might the various intersecting facets of your identity alongside the social and historical contexts of your school institution influence your attention to, interpretation of, and actions in responding to issues of equity in mathematics education?

2. How can teachers serve as leaders (with formal titles or with informal activities) to promote more equity in mathematics teaching and learning in your context?

3. How might teachers center the critical axis of equity in combating systems of oppression, including deficit thinking toward students and the devastating practices of academic tracking in mathematics?

4. How can we continue the conversations and move toward more equitable teaching and learning mathematics in today's political climate?

5. How can we harness feelings of discomfort and contradiction to move us toward positive changes in mathematics education?

The mission of TODOS: Mathematics for ALL is to advocate for equity and high quality mathematics education for all students—in particular, Latina/o students.

Five goals define the activities and products of TODOS: Mathematics for ALL

1. To advance educators' knowledge and ability that lead to implementing an equitable, rigorous, and coherent mathematics program that incorporates the role language and culture play in teaching and learning mathematics.

2. To develop and support educational leaders who continue to carry out the mission of TODOS.

3. To generate and disseminate knowledge about equitable and high quality mathematics education.

4. To inform the public and influence educational policies in ways that enable students to become mathematically proficient in order to enhance college and career readiness.

5. To inform families about educational policies and learning strategies that will enable their children to become mathematically proficient.

"DARE to Reach ALL Students!"

Teaching Preservice Early Childhood and Elementary School Teachers Mathematics Through a Social Justice Lens

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Abstract

We describe the objectives and some outcomes of a mathematics course for preservice elementary and early childhood education students that is focused on presenting mathematics through a social justice lens, as well as some examples of activities and content with which students engage throughout the course. Activities based on ratio and proportional reasoning are very accessible to students and yield fruitful discussions around notions of fairness and justice. We close with examples of student projects and feedback collected over several semesters.

Discussion And Reflection Enhancement (DARE) Pre-Reading Questions

1. We often hear children say, "That isn't fair!" Many societal problems ultimately come down to a sense of *fairness*. How can mathematics help us measure fairness?

2. Reflect on your own experiences learning mathematics. What messages did you receive (explicitly or implicitly) about who "belongs" in mathematics? How might these experiences influence your approach to teaching mathematics?

3. How can presenting elementary and early childhood mathematics content through a social justice lens impact preservice teachers and their view of mathematics in the world?

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Julie Klipfel (julie.klipfel@salemstate.edu) is an Adjunct Professor at Salem State University and an elementary school educator. With a background in both K-12 and higher education, Julie's experience spans numerous settings. Julie's expertise lies in teaching mathematics content and methods courses to aspiring early childhood and elementary educators, in addition to supervising students during field placements.

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Teaching Preservice Early Childhood and Elementary School Teachers Mathematics Through a Social Justice Lens

Christopher Yakes and Julie Klipfel

The idea of teaching mathematics through a social justice lens is well examined and has been trailblazed by many distinguished researchers. An entire issue of *TEEM* is devoted to these ideas, and many prominent scholars have investigated the outcome of using social justice mathematics content to engage students from elementary school through college. At Salem State University, the Department of Mathematics had the opportunity to create a course for preservice early childhood and elementary educators that presents the content of upper elementary and early middle school through a social and economic justice lens. In the view of the authors, this means that mathematics content is presented and explored as much as possible by starting with a mathematical artifact based on real-life situations—a news story, some data or a graphical representation of data, or a plausible story problem—and engaging students in thinking about the implications of the artifact. We will present some examples of such artifacts and related activities, specifically in *ratio and proportional reasoning*, which naturally allows for discussions about *fairness*. Then we share some student feedback illustrating course impact on their perspectives.

In 2019, the Salem State University Department of Childhood Education and Care created a new major for prospective early childhood and elementary education teachers, titled *Justice in Education*. As part of the major, a third mathematics content course was added to the curriculum, one that would focus on the mathematical topics in upper elementary grades and middle school. One stipulation for this new mathematics course was that the course be tied into social justice issues as much as possible. This task presented a unique opportunity, in that such a course did not yet exist at Salem State, and resources for implementing courses for preservice childhood educators do not typically focus on social justice.

The authors of this article created the course and collaborated on the first iterations of the course. When considering a theme and topics for the course, the question of how to interweave mathematics topics and social justice issues authentically is paramount. The major theme determined by the team for the course was: *to the extent possible, every mathematical topic would be introduced by exploring an issue around social justice first*. Thus, beyond simply using application problems or exercises to demonstrate the concepts and skills of the course, the concepts and skills would instead be introduced in the context of a social justice issue. As the creators of this course, Dr. Yakes and Ms. Klipfel, approached this work acknowledging both their commitments to mathematics education and social justice, as well as the importance of examining their own positions of privilege in undertaking this work.

While a mathematics PhD student at UCLA, Dr. Yakes began working with the California Mathematics Project, and he has continued working with teachers in several different capacities for the past 20 years. He has facilitated professional development workshops, provided coaching to teachers and technical assistance to schools, and after arriving at Salem State, began teaching math methods and supervising teaching candidates during their practicum. Over time, his interest in issues around equity and social justice started to enter his educational work, and the opportunity to help create this course represented a chance to fully integrate these interests. Dr. Yakes keeps at the forefront of his mind an awareness of the privilege and social capital being a highly-educated white male has afforded him. At the same time, being a first-generation college student from a working-class background, he is acutely aware of issues around wealth disparities and the divide between the working and professional classes. Dr. Yakes has made it a personal and professional goal to be an advocate and ally to students from under-represented backgrounds in mathematics and mathematics education.

With backgrounds in both mathematics and elementary education, Ms. Klipfel brings a unique perspective to mathematics education through dual roles as an elementary school teacher and adjunct professor working with preservice educators. Her experience teaching future teachers while maintaining an active role in the elementary classroom has deepened her understanding of how critical a robust teacher preparation program is for developing effective mathematics instruction. Over time, she has witnessed how building a strong mathematical culture in the classroom is essential for

successfully integrating social justice perspectives in mathematics instruction. Through her position at the intersection of elementary education and mathematics instruction, and mindful of her privileged experiences as a white, English-speaking female growing up in a Boston suburb with access to high-quality education, she has made it her mission to prepare future teachers to create inclusive, engaging mathematics classrooms where all students feel a sense of belonging.

Creating a Course Focused on Mathematics through a Social Justice Lens

The development of this new course provided an opportunity to explicitly link the teaching of mathematical concepts and skills to student consideration of social justice contexts. We feel it of utmost importance that preservice teachers see that mathematics can inform their understanding of the world. This serves the dual purposes of helping to develop their sense that mathematics is productive and useful, as well as opening their eyes to real problems around equity and social justice. Most of our preservice teachers will graduate and teach in schools where many students experience poverty, are members of oppressed and marginalized groups, and for whom English is a second language. To become advocates for and allies of their students, it is important for preservice teachers to understand the structural impediments existing for many, and mathematics can help them develop this understanding. Further, as our work and the work of others shows, teaching mathematics through a social justice lens deeply engages students and motivates them in ways that an objective, positivist curriculum often does not. As James Banks (2014), considered the father of multicultural education, writes, "Students are more likely to master skills when the teacher uses content that deals with significant human problems related to race, ethnicity, and social class within society." (p. 6)

In a series of works, Marilyn Frankenstein describes a framework through which students may develop what she terms *criticalmathematics literacy*. Frankenstein builds on the work of Freire and several others, most notably appealing to the notion of "problem posing" as a means for instructors to co-construct content with students (Frankenstein, 1983). Her work is an extension of the ideas of critical pedagogy to mathematics teaching. Specifically, she gives several examples of how university students in a statistics course can be encouraged to critically examine injustices present in society as well as in the "standard curriculum" of such a course. In the course presented here, we attempt to do the same: frequently an infographic or collection of data is presented to students, and they are asked to investigate the implications for society they perceive. Mathematical tools are introduced to comprehend the data, as well as make arguments for or against the status quo that is often present in such examples.

Gutiérrez (2019a, 2019b) describes the inherent tensions in teaching mathematics with a focus on equity. We attempt to diffuse some of these tensions by getting to know our students through mathographies and by employing open discussions of the "What do you notice, what do you wonder?" style. These serve to include a human element into the course—indeed, this is not the typical math class these students have encountered. The focus is on real issues around social justice as well as the mathematics content and building trusting relationships among students and instructor is critical. Recognizing these inherent tensions, we introduced many topics in the course with content advisories, and the discussions often became spaces for collaborative learning where instructors and students together explored sensitive concepts.

We are further inspired by the work of Jo Boaler (e.g. Boaler, 2013), in that an important theme for this population of students is the notion of *democratizing mathematics*. We take this term to loosely describe the shifting of mathematical agency to students rather than only to the instructor. We also emphasize the notion of collectivism—in the Vygotskian sense of co-constructing knowledge using social tools (like language), in contrast to American notions of an individualistic society. This is particularly important not only for the present course, but for the future classrooms of these prospective teachers, many of whom have experienced classrooms emphasizing rote memorization and skills, a glossing over of conceptual understanding, timed tests, or negative attitudes towards mathematics. Thus, while one goal is engendering a productive disposition, we try to embody the eight Standards of Mathematical Practice (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010) and the NCTM Process Standards (NCTM, 2000) in implementing the course. This means providing opportunities for problem solving, for making arguments and critiquing

others' reasoning, and for class discussions about procedures and concepts. This attempt to democratize our own mathematics classroom serves to further elicit and make public the inherent tensions described by Gutiérrez (2019b).

Before moving on, we must make note that in class discussions around many of these ideas, the notion of "fairness" will arise, and this is precisely the type of discussion we should want in a course such as this: that is, when can we quantitatively decide something is "fair"? Some will want to avoid such discussions in a course designated as a mathematics content course. We feel strongly this is entirely appropriate for this group of students, especially at this period in U.S. history. It is imperative to give students the space to grapple with ideas of fairness and to equip them with the quantitative tools for decision-making as they embark on their careers. Furthermore, in this way, students are *reading and writing the world with mathematics*, as described by Gutstein (2016).

Engaging Students in Social Justice Mathematics Activities

Being the third mathematics course in a sequence for childhood educators, the content is focused on upper elementary and middle school. Many topics ultimately connect to the area of ratio and proportional reasoning, which is particularly rich for engaging students in mathematics arising from social justice scenarios. Below are three topic areas and example artifacts that presented opportunities for rich discussion among students.

Topic 1: Absolute and Relative Reasoning

In the course, we begin with the contrast between *absolute* and *relative thinking* (Lamon, 2020). Consider for example the following hypothetical situation we present to students:

> *A stockbroker and his assistant pay federal taxes on their income. The broker made $2,000,000 last year, while the assistant made $60,000. The broker paid a total of $300,000 in taxes, while his assistant paid $21,000 in taxes. Who paid more in taxes?*

An absolute reasoning view of this problem answers that the broker paid more in taxes. However, we encourage students to investigate further by allowing students to engage in discussion and by prodding for some thinking about comparing the amount of tax *relative* to the income of each person. Students begin to implement fraction reasoning and percentages, which may require some scaffolding along the way. In the end, they can all see that there is an argument that the assistant paid *more* in taxes, relative to their income. Using percentages, we see this more clearly: the broker paid 15% of his income in taxes while the assistant paid 35%. Figure 1 demonstrates two student responses to the problem, wherein students make effective use of tape diagrams to illustrate their thinking.

Perhaps this example seems farfetched. However, students can be encouraged to read about the ways the ultra-wealthy in the U.S. pay a lower effective tax rate than lower-income earners. They can learn about tax brackets, taxes on business profits, and the like, and engage in discussions about what seems reasonable to them or experiment with hypothetical situations regarding tax revenue and the use of taxpayer funds.

Many examples can be found for using similar infographics or data to introduce and explore relative and absolute thinking and related topics. First, students can consider whether sales tax is fair; while sales tax appears to be uniformly applied to all subjected purchases equally, the absolute amount of taxes paid will have an outsized effect on someone making a lower income. Students may be led to wonder why certain items are not taxable in their state. This example also allows for the opportunity to discuss progressive and regressive taxes, and to investigate the feasibility of a "flat tax" with a common fixed rate (on income, say), which on the surface appears to be the fairest way to tax people of all but may not actually be so.

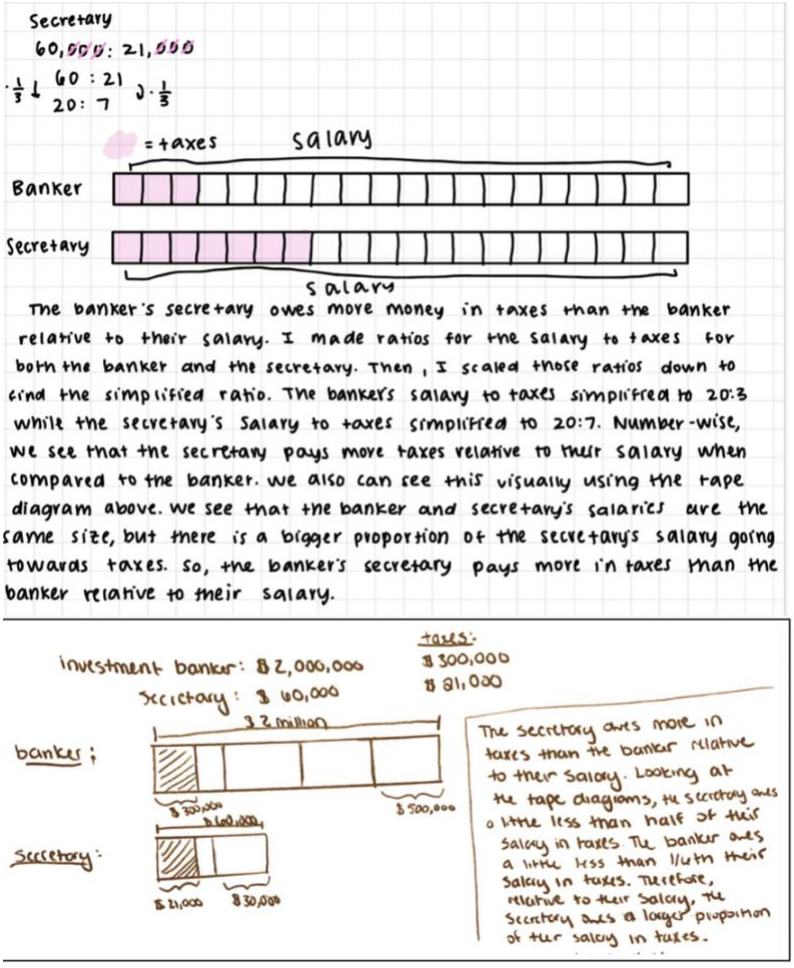
Proportional representation in government is another rich area in which to explore the basic notions of relative and absolute reasoning. The class can research the number of representatives in the U.S. House of Representatives for their state, and compare that number to another state's, relative to population. Consider the question presented below:

> *New York has a population of about 19.8 million and 27 representatives in the House of Representatives, while Massachusetts has a population of about 6.89 million and 9 representatives. Do these situations represent equivalent ratios?*

Students may find that even though the representation in the House is not exactly equivalent, it is more-or-less proportional. Students can be asked a similar question about the U.S. Senate, wherein they may be very surprised to find quite a different answer. Again, infographics and sources of data abound to help explore this idea.

Figure 1

Comparing Taxes Relative to Salaries, Where the Taxes Paid Are Commensurate, to Make an Argument



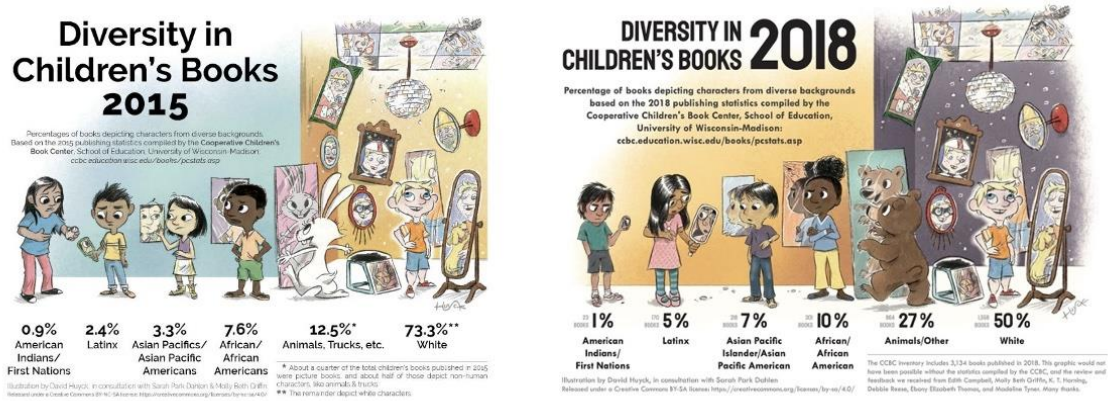
Topic 2: Working with Percentages and Percent Reasoning

In 2020, the Alabama State Legislature drew a new congressional districting map that appeared to disenfranchise Black voters. The population of Alabama is roughly 27% Black, while the new map carved up areas of Alabama that are majority Black in such a way as to create only 1 district out of 7 that is majority Black. The case eventually went to the U.S. Supreme Court. This scenario can be presented to students, who can discuss the implications of the new map and can be introduced to gerrymandering, critical for understanding current power structures in state governments around the U.S (de Vogue, 2023).

Another interesting example for preservice childhood educators includes the infographics in Figure 2, which describe the breakdown of diversity in children's book characters in two different years. Students can be asked both how the percentages changed in an absolute sense and a relative sense, using the concept of percent change to express their answers.

Figure 2

Diversity in Children's Books 2015 and 2018. (Hyuck et al., 2016, and Hyuck et al., 2019)



Topic 3: Comparing Linear and Exponential Patterns

While we do not necessarily expect our students to develop expertise in growth rates, it is worthwhile to investigate the difference between constant additive change (linear change, a middle-grades topic) and constant multiplicative change (exponential change). One of the more fruitful areas for investigating this is the basic notion of wealth inequality.

As a simple but thought-provoking example, students can be asked how long it would take someone earning the federal minimum wage to make a billion dollars. They may be surprised by the answer. They can then investigate graphs such as the one in Figure 3, which demonstrates an essentially exponential growth in someone's wealth (noting that the horizontal axis does not represent equal-size intervals).

Throughout the different overarching mathematics topics introduced in class, students were often asked to design their own problems or take their learning from class to explore a social justice topic further in the context of the mathematics learned. While working with linear functions, one student posed a problem that involved the 49:1 ratio in Massachusetts of white K-12 teachers to K-12 teachers of color. The question had several parts, which included using a table, equation, and graph. The student's work is shown in Figure 4.

Finally, while the question of how long it takes someone earning minimum wage to become a billionaire is somewhat whimsical, there are very real questions regarding patterns and growth that can be framed to make students think about economic issues in a different light. For example, the Prison Policy Initiative (https://bit.ly/4ktDbAT) reports that in 2017, incarcerated persons in Massachusetts made as little as $0.14 per hour (Sawyer, 2017). Students can determine how many hours such a person must work to be able to afford an essential item in the commissary that costs $10.

Figure 3

Approximate Net Worth of Warren Buffett Over Time (Source: https://bit.ly/3TtxS9M)

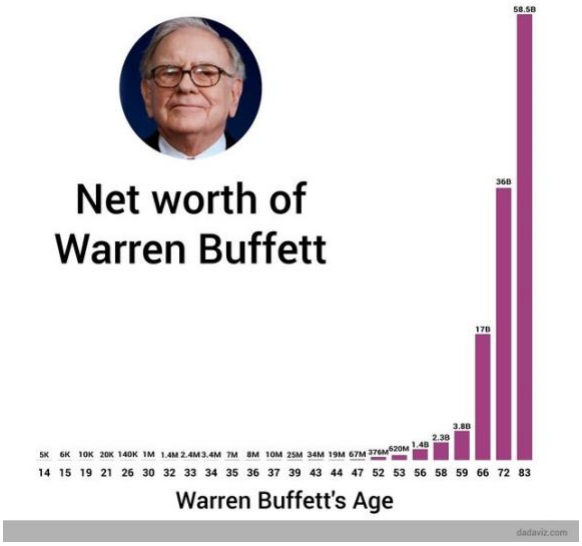
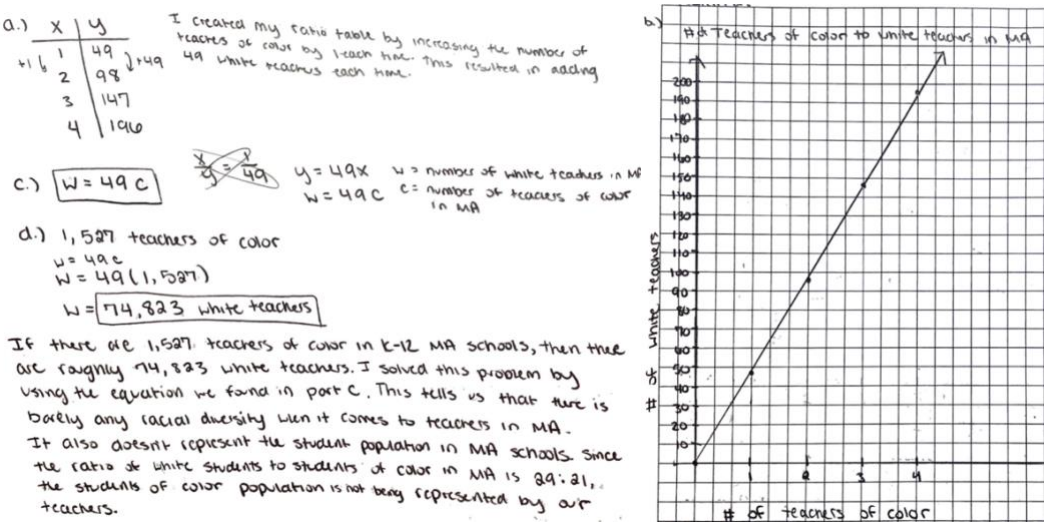


Figure 4

Student Work on the Ratio of White Teachers to Teachers of Color in MA



Impact on Students

In the first iterations of this course, both instructors implemented a final project as a culminating assessment. Students worked individually or in pairs and were required to apply some of the skills and reasoning developed throughout the semester to a social justice topic of their choosing. Many students made use of Census.gov (https://www.census.gov), a tool that was introduced during the semester to find interesting demographic data to ask questions around diversity trends.

Final Projects

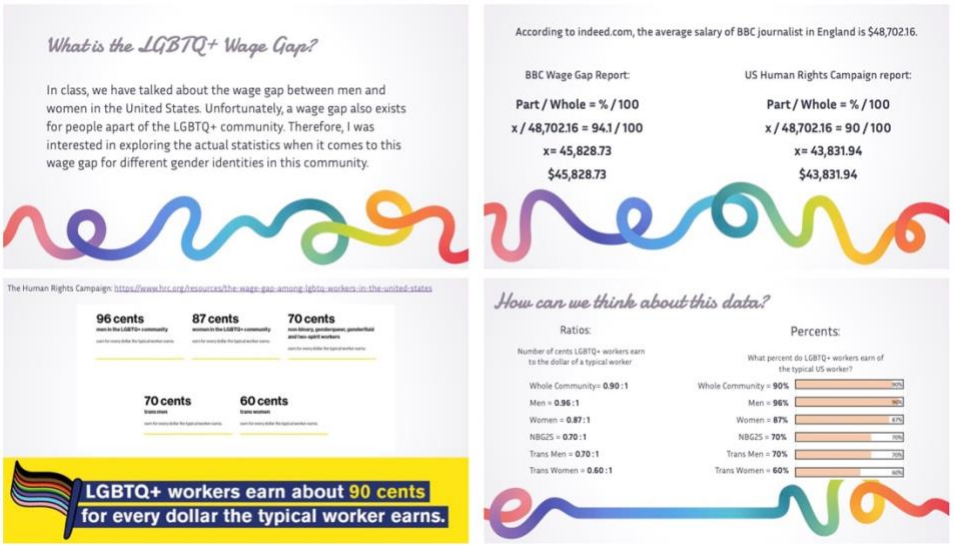
We present two examples of student final projects as evidence of the impact the course had on students, both mathematically and in their awareness of social justice issues. Most students created a slideshow to present during the final class meeting or the final exam period. Topics varied quite a bit, as students were inspired to research social justice issues they cared about and showcase the mathematics they had learned.

Project 1: LGBTQ+ Wage Gap

One student used her content learning from the course, particularly regarding ratios and percentages, to analyze the LGBTQ+ wage gap in the United States. She wrote, "Everybody knows that there are wage gaps between men and women, but some might not realize that these wage gaps extend to people in the LGBTQ+ community." As presented in her final project, she took data to then create ratios, percents and even precent bars to show the pay gaps (Figure 5).

Figure 5

Student project on the impact of LGBTQ+ wage gap



She took her mathematical investigation further to research the LGBTQ+ wage gap in other countries, again applying her learning about ratios and percentages. In her final reflection. she wrote, "I thought it was important to show the class how this issue was not just happening in the United States and that it was happening worldwide." In addition, she explored the impact this would have on LGBTQ+ teachers in the state she plans to work (Figure 6).

Figure 6

Exploring LGBTQ+ Wage Gap Impact in Massachusetts

In her final reflection, this student wrote:

> Both the Human Rights Campaign and the BBC Studios report show that this is a real issue that many people might not realize. More research needs to be done in order for people to understand the urgency. Also, based on my calculations, trans women face the most discrimination when it comes to the wage gap. When estimating the average teaching salary, I found that trans women would make roughly $34,000 less than the typical teacher...While there are anti-discrimination laws in Massachusetts, more has to be done to protect LGBTQ+ workers.

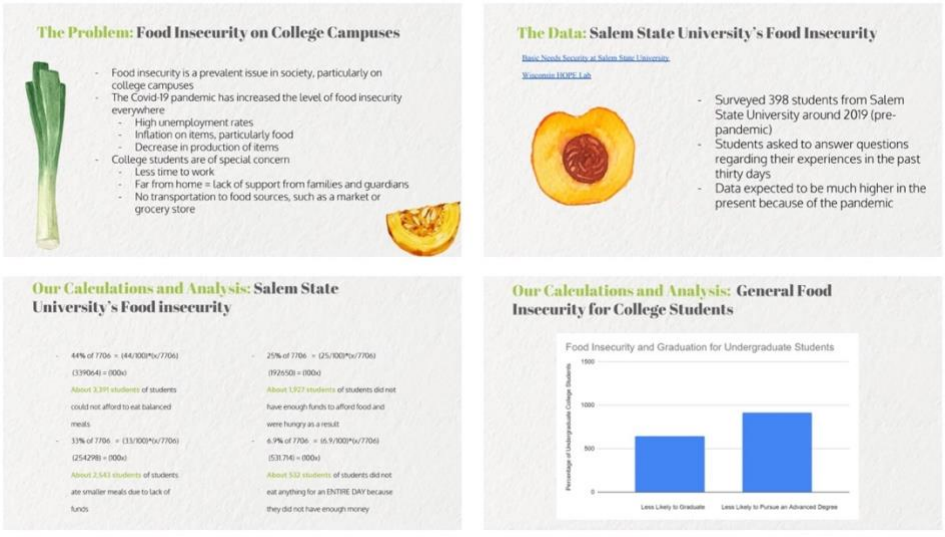
This student's final project examining LGBTQ+ wage gaps demonstrates the successful application of course concepts to meaningfully investigate social justice issues important to them while also further investigating the notion of fairness. This work exemplifies how mathematical inquiry can deepen students' understanding of societal inequities on a global scale and connect directly to students' future professions. The depth of this investigation demonstrates the power of the course's approach of introducing mathematical concepts through a social justice lens.

Project 2: Food Insecurity on College Campuses

One group of students investigated data on food insecurities on college campuses across the United States, including specifically at the college they attend. They presented their findings using knowledge of percents and ratios gained from the course (Figure 7).

Figure 7

Student Project on Campus Food Insecurity



In their final reflection, the students wrote, "This report reinforced the idea that food insecurity is a major issue at Salem State University and colleges across the United States, and that we must do something to combat it." This has shown how powerful the use of real-life mathematics can be in opening preservice teachers' eyes to social justice issues around them.

It is also important to note that the final projects allowed students to share social justice topics important to them that we might not have covered in the course. This provided another valuable learning opportunity where the instructors could experience learning moments alongside our students. For example, one final project presented mathematics related to the GSA, which many historically knew as the "Gay-Straight Alliance." Through the student-led presentation, the class learned that it has evolved to the "Gender and Sexuality Alliance." Such moments of shared learning highlight how the approach to mathematics education in this course creates spaces for continued growth and understanding for everyone involved.

Conclusion

The literature around mathematics for social justice is extensive and growing. This paper describes a context wherein future early childhood and elementary teachers develop a better awareness of social justice issues while developing an understanding of upper elementary and middle school concepts, specifically ratio and proportional reasoning. This audience is well-suited for this course that presents the mathematics as a tool for empowerment and helps students improve their disposition towards mathematics.

We feel that mathematics educators have an obligation to respond to recent political events, which include attacks on education as well as on vulnerable communities, and that now is the time for increasing preservice teachers' awareness and understanding of issues around social justice that they may already encounter in their personal lives and will likely encounter in their professional lives. Our goal in creating this course goes beyond simply increasing our students' understanding of upper elementary grades mathematics content; we seek to develop in our students the capacity for viewing social issues through a quantitative lens, with which they can understand and make informed arguments and decisions.

Our intention is that this paper inspires others to take risks in their own instruction in presenting mathematics through a social justice lens and challenging their students to expand their worldview and see themselves as empowered to make a difference in their and their future students' lives.

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Discussion And Reflection Enhancement (DARE) Post-Reading Questions

1. As described in this paper, proportional reasoning—ratios, rates, percentages—is a big idea in mathematics that can be applied to many real-world situations. Discuss with a colleague some other ways that proportional reasoning can help us describe *fairness*.

2. What are some other big ideas in mathematics that have their own wide-ranging applications to social justice topics?

3. Find a recent article that presents data and uses percentages (or ratios or rates) to discuss a real-world scenario. Think about how to present the data in a way that causes your students to think about the social-justice implications of the data.

4. Team up with a colleague from a different discipline (e.g., social studies or science) and co-plan a unit in which students must use mathematics to describe the world around us.


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Leveraging Children's Multicultural Literature to Support Students' Math Identity and Problem Solving

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Abstract

This article explores how multicultural children's literature for elementary classrooms can be leveraged to develop students' mathematical understanding and foster positive math identities, particularly for multilingual learners. By integrating diverse stories into mathematics instruction, teachers can create culturally relevant contexts that invite meaningful problem-solving in tandem with rich mathematical discourse. This article features a classroom vignette in which a third-grade teacher uses the book *Too Many Tamales* to engage students in an equal share task, demonstrating how students' cultural experiences enhance their conceptual mathematical understanding. Several pedagogical strategies are highlighted as effective ways to support mathematical reasoning and understanding through authentic mathematical discourse. Drawing from classroom practice and supported by research, the authors advocate for the use of multicultural texts to provide meaningful opportunities for students to connect their lived experiences to mathematical ideas, empowering them to see themselves as capable mathematicians.

Discussion And Reflection Enhancement (DARE) Pre-Reading Questions

1. How do you represent your students' home cultures in your math lessons?
2. What connections can you make between texts that represent different cultural and linguistic backgrounds and students' math identities?
3. What strategies have you or would you like to use to engage students in academic discourse in math?
4. How do you select or plan to select texts that represent diverse students and support opportunities to engage in authentic conversations in ways that are connected to their lived experiences?

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Leveraging Children's Multicultural Literature to Support Students' Math Identity and Problem Solving

Introduction

Integrating literature and mathematics can create meaningful, context-rich learning experiences for multilingual students. In today's math classrooms, many teachers have underutilized literature, perhaps worried about time constraints or moving focus away from math instruction. In this article, we argue that by incorporating multicultural literature into math instruction, students can develop deeper understandings of mathematical concepts as they engage in meaningful conversations that reflect their own experiences and backgrounds. Moving beyond word problems, literature offers opportunities for mathematical thinking, context and cultural relevance. Leveraging children's literature that highlights diverse characters and communities can support multilingual students' mathematical understanding and foster positive math identities. Often, students of color do not see themselves represented in the texts they read (Education Trust, 2023). Using multicultural texts to introduce and explore math concepts gives learners space to ask their own questions, and make connections among stories, their lives, and the world around them (Iliev & D'Angelo, 2014). Selecting books that reflect the diverse cultural and linguistic backgrounds of our students can provide relatable contexts for investigating math. It is important for multilingual students to see themselves and their languages, including translanguaging, in the stories they read. Monolingual students benefit by seeing multilingualism represented and celebrated, which can expand their worldviews (Fan et al, 2015). There is a strong research-base for weaving literature into mathematics lessons. Buchhheister et al. (2021) used Shel Silverstein's

"Band-Aids poem" to showcase how content-implicit literature can lead to mathematics lessons that are focused on "fairness and equity in a real-world situation" (p. 16). Integrating children's literature in elementary mathematics can lead to significant gains in student understanding and retention of mathematics concepts (Thomas & Feng, 2015).

We offer a starting point for how teachers can support students with exploring and investigating math through story. For example, how might different cultures relate to this problem? How might students see themselves or relate to the math problem in the story? Reflecting on these questions are ways to promote a positive math identity for students. Mathematics identity refers to the "dispositions and deeply held beliefs that individuals develop about their ability to participate and perform effectively in mathematical contexts and to use mathematics to change the conditions of their lives" (Aguirre et al., 2013, p. 14). Introducing math vocabulary connected to math stories can further support students with understanding what it may look like to halve something or double something. Students can explore what it means to share something *equally.* Math investigations, inspired by multicultural literature, can provide authentic opportunities for students to communicate and work together as a community as they persevere to solve problems presented in stories. To illustrate how multicultural literature can bridge math and culture in the classroom, let's look at an example from Ms. Hernandez's third grade class, where she thoughtfully integrates literature into a math lesson that reflects both the cultural and language backgrounds of her students and springboards into key mathematical concepts. She uses the book *Too Many Tamales,* where a young girl named Maria helps her mother make tamales for a holiday celebration. While cooking, she tries on her mother's diamond ring and later realizes it's missing and probably lost in the tamales. Maria and her cousins secretly eat all the tamales trying to find the ring. In the end, they confess, only to discover the ring was never lost. The story highlights themes of family, honesty, and holiday traditions.

This article is based on the work from a 5-year IRB-approved project funded by the National Science Foundation as a collaboration between a university and a large school district in southern California. Together, we developed professional development opportunities to support teachers working with English learners in integrated English Language Development math classes with students in grades 3-5. Classroom observations and teacher reflections inform the vignette and ideas shared below.

Vignette

Ms. Hernandez's third-grade class gathers on the carpet for their weekly read-aloud during math class. The learning objective is posted on the board behind her: *Students will develop a conceptual understanding of division by solving equal-sharing problems from story*. The teacher begins by sharing the book cover with her students. "Today, we will be reading the book *Too Many Tamales*, by Gary Soto. Can anyone tell me what you think this book will be about?"

An eager student named Veronica waves her hand with excitement. When she finally gets to share, she says, "I think it will be about tamales! I love tamales! I make tamales with my abuela in December. We always make dozens and dozens so maybe this book will be about how long it took them to make all the tamales, what kind of tamales they made, or which family members ate the most tamales. I am hungry now, Ms. Hernandez! Do we get to eat tamales afterwards?"

Ms. Hernandez giggles and praises Veronica for her excitement and for sharing her experience and asks others to relate to what Veronica said. Some students spoke about other foods their family prepares for special occasions and how they share them with extended family and neighbors. Anh says he thinks he is really good at math because he measures all the ingredients needed to help make his family's famous shrimp dumplings. He also keeps track of the time and temperature needed to cook dumplings. Anh is excited to find out if the tamale story includes a lot of information about measuring, time, and temperature.

Ms. Hernandez proceeds to read the text aloud. She stops along the way to ask students to retell what is happening in the story. She has students talk about what tamales are since some students may not be familiar with this food. She asks students to identify quantities of tamales shown in the illustrations. She asks students to make connections to the problem in the story. She then presents the class with a math investigation from the story:

> *In the story, there were 24 tamales. Maria and three other children ate all the tamales. If each child ate the same amount, how many tamales did each child eat?*

Students work in groups of four using cornhusks and play dough, as manipulatives, to represent the tamales and come up with their solution. Ms. Hernandez circulates to listen to all the groups' conversations. Some students question their peers, suggesting a different solution. Students explain in greater detail why they think their solution is correct in order to convince peers that seem to disagree. Ms. Hernandez asks a few groups to share aloud in front of the class. She also asks students to create some new math investigations that could be tied to the story.

Math Identities and the Role of Multicultural Literature

In the vignette above, many of Ms. Hernandez's students were able to connect with the story, *Too Many Tamales*. Some felt connected because they saw themselves in the characters. Others felt connected because they related to close familial ties represented in the book. Others were able to relate to family gatherings which often included special foods. Using this story played a facilitating role in fostering students' positive math identities, which are deeply influenced by their cultural and linguistic backgrounds. According to Leonard et al. (2013), multicultural literature makes math more relevant and accessible to students from diverse backgrounds. The act of engaging with literature, alongside math, helps students see themselves as mathematicians. These books also highlight contributions from different cultures, allowing multilingual students to see themselves represented in math stories. This can result in increased engagement and foster a sense of belonging (Altun, 2023; Colby & Lyon, 2004; Robinson, 2023). Representation matters in fostering a positive math identity.

Positive math identities are crucial for academic success and personal growth. Students belong to multiple microcultures related to race, culture, gender, family, faith, and language, all of which shape their identities (Safi et al., 2021). Our identities have also been shaped by educational experiences in both positive and negative ways. Math identities are complex and change over time. It is critical to explore the math identities of our students and provide opportunities for them to see their funds of knowledge and assets (Civil, 2016; Moll, 2014; Wilson et al., 2020) represented in texts.

The Different Roles of Multicultural Literature

Multicultural literature offers students opportunities to engage with math in meaningful and culturally relevant ways (Leonard, 2008). To fully understand how these texts support students' mathematical development, it is essential to explore the different roles that multicultural literature can play in the classroom—whether it's attending to culture, language, or mathematical concepts themselves.

Attending to Culture

Multicultural literature can play a significant role in affirming cultural identities, in supporting cross-cultural understandings, and in promoting inclusivity (Wheeler & Hill, 2023). Multicultural books can provide students with characters and stories who reflect their lived experiences, values, and traditions. By representing diverse cultural and linguistic backgrounds, books can validate and celebrate the identities of students in our classrooms. In Bishop's (1990) seminal work, she describes books as windows, mirrors, and sliding glass doors that serve to reflect the student's culture (mirror), offer a view into others' lives (windows), and invite students to participate in different cultural experiences (sliding glass doors). Multicultural literature can also foster cross-cultural understandings, dismantle stereotypes, and build empathy by exposing students to diverse cultural experiences and perspectives. Stories that authentically depict the complexities of different cultures and experiences help students develop a deeper understanding of others, challenging monolithic or prejudiced perspectives (Briceño & Rodriguez-Mojica, 2022). In addition, multicultural literature often incorporates themes and narrative that resonate with specific cultural values, struggles, and triumphs. They provide a medium to explore topics like bilingualism, immigration, generational conflict, and racial identity (Wee et al., 2021). In the book, *That's Not My Name!* by Anoosha Syed (2022), the central character Mirha shares her frustrations with having her Arabic name repeatedly mispronounced. Multicultural literature can also enhance social and emotional learning by presenting diverse life experiences and nurturing empathy, resilience, and cultural competence (Gay, 2021). For example, in *Areli is a Dreamer* (2021), Areli Morales shares her story of being a Dreamer as a Deferred Action for Childhood Arrivals (DACA) recipient,

mirroring other's experiences and providing a window for others to develop cultural competence. This book can be used to explore concepts of estimation, measurement of time, sequencing, and unit conversions.

Providing students with familiar contexts, such as leveraging the proportional reasoning involved in making watermelon smoothies or coconut pudding in the Pacific Islands, enables learners to make connections with more rigorous content and strengthens their identities as doers of mathematics (Hunter & Restani, 2021). Using multicultural texts with math connections allows students to see that math is not just a "western thought" but that ancient civilizations around the world have used math for thousands of years (Hunter & Hunter, 2023). For example, Seneb and Merti are the two main characters in *If You Were a Kid Building a Pyramid* by Schimel who share what they know about the materials and tools used to build Egyptian pyramids, exploring concepts of geometry, ratios and proportions. In the book *Mararíki*, authors Brown and Parkinson use rich imagery as well as Maori and English text to explore how the Maori people navigated their boats at night by stars, exploring concepts of measurement and statistics.

Attending to Language Through Translation and Translanguaging

While culture plays a central role in how students engage with literature and math, language is also important. In fact, language, especially in multilingual classrooms, is a powerful tool for deepening mathematical understanding and building math identities. Language is a central part of students' identities (Darvin & Norton, 2017). Garcia and colleagues (2017) discuss the value of allowing students to use their full repertoire of language, which includes students' languages, dialects, and registers. Hence, there is great value in books that reflect students' linguistic backgrounds. Furthermore, books that use translation and translanguaging expose children to multiple languages, whether or not they are familiar with those languages. Many books use translanguaging to highlight the language and cultural aspects that are embedded into the story, such as *Isabel and her Colores go to School* by Alexandra Alessandri (2021). The author wrote most of the book in English and uses Spanish terms when describing colors, feelings, or artwork that the main character expresses when thinking in her first language. Exposure to translanguaging in books is a helpful resource for students when setting the stance that they are allowed to use their full linguistic repertoires for learning and when communicating ideas during classroom instruction (Garcia, Ibarra Johnson, & Seltzer, 2017). Some books touch upon this idea by translating in multiple languages, such as books from the Story-Telling Math series like, *¡Hasta las rodillas! Up to my Knees!* (2022), which is written in both Spanish and English and features measurement for young children 0 - 3 years old.

Attending to Mathematical Concepts

Stories involving math provide contextual opportunities for students to engage with math concepts through story. Integration of literacy and mathematics provides ''context and engaging scenarios for students to grasp difficult mathematics concepts'' (Koellner et al., 2009, p. 38). Some texts center around math concepts as the core of their narratives, providing students with concrete and relatable ways to explore ideas such as fractions, measurement, and division. For example, the *Sir Cumference* series (Neushwander, 2007) and *Fractions in Disguise* (Neuschwander, 2005) are stories that center math concepts, but do not necessarily provide a multicultural context. After reading Fractions in Disguise, students can sort fractions into "disguises" of the same number or create a fraction gallery featuring equivalent fractions. In a book from the series, *Sir Cumference*, students are introduced to the concept of pi and circles in a fun and engaging way. This story can spark a series of inquiries about circles, pi, and the geometry involved, where students can experiment with drawing circles, measuring diameters, and calculating areas. *Spaghetti and Meatballs for All* (Burns, 2008) is a mathematical story that explores the distinction between surface area and perimeter, specifically while the various configurations of the eight tables have the same surface area, the same cannot be said about the perimeter. By presenting mathematical concepts and vocabulary through literature we can provide students with the "context and engaging scenarios to grasp difficult concepts" (Koellner et al., 2009, p. 38).

Attending to Culture, Language, and Math

Focusing on the math ideas found in multicultural books provides students with opportunities to learn mathematical concepts in meaningful contexts. These opportunities are necessary in making mathematics accessible and for helping students use literature and mathematics to make sense of their lives (Lo Cicero, Fuson, & Allexsaht-Snider, 1999). *Luna's Yum Yum Dim Sum* (Yim, 2020) is an example that integrates many of these concepts, by using a playful problem about equal sharing in a multicultural context to explore fractions and division. On Luna's birthday, the whole family goes out for dim sum -- but Luna and her brothers can't agree on how to share their pork buns fairly. How can three people divide up five buns? Comprehending the story is dependent on understanding the equal-sharing math investigation presented in the book. The problem also invites students to consider how food is shared during family gatherings, which is a common cultural practice in many Asian communities. By framing the math problem in a familiar cultural setting, students can better relate to the task and feel more invested in solving it. This promotes a positive math identity where students feel they are do-ers of math. Students are able to have authentic conversations about equal-sharing problems in ways that are meaningful and connect to their lived experiences. The book incorporates vocabulary (e.g. baba, dim sum, char siu bao) that may be part of a register familiar to some and unfamiliar to other students. *Luna's Yum Yum Dim Sum* is available in English and also in a bilingual (Spanish/English) version. In the latter, the story is written in Spanish with English on the same page under the Spanish text. This allows for native Spanish speakers to see and hear the story in their native language along with the English text under it, supporting dual language development. By reading the text in both languages, students strengthen their vocabulary and language skills in both.

Although it is beneficial for books featuring math concepts to be written in multiple languages, it differs slightly from the power of translanguaging where both languages are used simultaneously. For example, *¡Mira Abuela! Ni Elisi! Look Grandma!* (Coulson, 2022), another book from the Story-Telling Math series for ages 3 to 6, covers all aspects of multicultural texts that feature math. First, there is the option of reading a Spanish-English bilingual version or a (mostly) English version. Second, both versions include Cherokee words interspersed throughout the book because the main characters are Native American. Third, the story uses a Native American context where the main character plans to sell traditional marbles for the Cherokee National Holiday festival. Lastly, the main character uses spatial reasoning and his understanding of volume/capacity to find a container that is the right size for all the marbles. By using texts like, *Luna's Yum Yum Dim Sum* and *¡Mira Abuela! Ni Elisi! Look Grandma!,* teachers can deepen mathematical understanding by leveraging cultural context and linguistic repertoires.

Revisiting Veronica, a student in Ms. Hernandez's classroom, the book *Too Many Tamales* has an authentic cultural and linguistic context that provided a scaffold for the mathematical concepts of equal-sharing using fractions and division. Her own family's tradition of tamale-making and the use of vocabulary that was familiar to her (e.g. tamales, masa) positioned her as an expert in the classroom. Given that the context was familiar to Veronica, the equal-sharing problem presented by the teacher is likely to lead to deeper understanding of mathematical concepts. At the same time, other students who may not be familiar with the context were provided opportunities to expand their cultural competence and make connections to their own lived experiences (e.g. Anh's connection to dumplings).

Using Literature to Promote Authentic Mathematical Discourse and Problem Solving

By using stories that are culturally relevant, teachers can encourage students to solve problems collaboratively, apply mathematical reasoning, and communicate their thinking in ways that are meaningful to them. Multicultural math stories can provide a context that students can connect to and engage with each other in conversations. These discussions allow students to justify their approaches, listen to others' perspectives, and refine their reasoning through peer feedback. The collaborative nature of solving problems through literature promotes the development of key mathematical skills such as logical reasoning and the ability to articulate and critique mathematical arguments. Using multicultural math stories can also promote students' ability to solve a math task in multiple ways. For example, in Luna's *Yum Yum Dim Sum*, students may solve the problem by distributing three pieces of dumpling to the three children in the story. Others may decide to use

a division algorithm (e.g., 5/3 because there were five dumplings and three sharers). These opportunities allow for students to see there is not just one right way to solve a math task. The math story allows students to think creatively, ask questions, and approach math with confidence as they share their thoughts with peers.

Math permeates our everyday lives, no matter what our cultural backgrounds are. Multicultural stories can help contextualize mathematical concepts within real world scenarios that are meaningful to students (Desai et al., 2021). For example, Anh (in the vignette presented above) makes a connection to the math he uses at home when making shrimp dumplings. He is eager to talk with peers about how he makes shrimp dumplings and shares the recipe his family uses. He also shares with the teacher and class about the different measuring cups and spoons he uses when helping his family make the dumplings. He discusses halves and fourths and how sometimes his family doubles the recipe. His engagement in the story and in the math task has already been established because of the connections he has made. He is ready to work and talk with his peers in solving the equal-sharing problem about tamales.

Let us revisit students in Ms. Hernandez' class as they work on the equal-sharing problem: Anh, Veronica, Kareem, and Sarah work together to solve the problem from *Too Many Tamales,* the book Ms. Hernandez read aloud to them. Veronica decides to get the group going and reads the problem aloud to her group.

Veronica: Pues, I will start by reading the problem: In the story, there were 24 tamales. Maria and the other three children ate all the tamales. If each child ate the same amount, how many tamales did each child eat?

Kareem: I think we should use the corn husks to help us figure this out. Let me count out 24. (Starts counting and plays around with the husks.)

Sarah: Pero, I don't think we need the corn husks - can I just draw them out instead? (Gets dry erase marker and whiteboard.)

Anh: Okay, so Sarah drew all the tamales for us. Make sure you drew 24. Let's figure out how many each kid gets. We have to split the tamales between the three kids and we have to do it the same…like equally.

Veronica: Right, cierto? - like each kid has to get the same amount. How about we label each tamale with who it goes to? Like the first one goes to child 1 who is probably Maria, then the second one goes to child 2, 3 for child 3. What do you think?

Sarah: Okay sounds good. (Sarah starts to label each tamale as her teammates count aloud with her.)

Anh: Wait you are confusing me - what do the numbers mean? Why are you putting numbers above the tamales?

Sarah: The numbers represent the kids. So, 1 is kid #1, 2 is kid #2, 3 is kid #3.

Veronica: Okay so I am going to count up all the tamales for kid #1. I got 8.

Anh: I counted 8 for kid #2 also and 8 for kid #3.

Sarah: Okay so each kid gets 8 piezas then, verdad? Kareem, are you going to help us out or are you still playing with the corn husks?

Kareem: Let me see what you did. How did you get 8? I don't think that is right? hmmm ... Oh you forgot a kid! We actually have to split them between four kids. You are forgetting it's Maria and three kids, so that is a total of four kids.

Anh: Oh that is right - I saw three in the word problem and was going with that. Oh no! We have to start over!

Sarah: It's okay, let me just erase the numbers again and we can redo it but this time label 1, 2, 3, then 4.

Kareem: The answer is 6 tamales for each kid.

Veronica: Wait - how did you get that so fast? Let us wait and count it all up after Sarah puts the numbers on top of each tamale.

Anh: Okay let me count…1, 2, …(the others start to count with him). Okay so the answer is 6 tamales. Do we all agree?

All the kids nod their heads. They are ready to report back to Ms. Hernandez.

Students in this group worked together to make sense of the problem, discussed how they would represent the tamales, and persevered to come up with a solution. This exchange also provides examples for how group work can promote community evidenced by the confidence with using primary language and holding each other accountable for learning. After re-engaging Kareem, he noticed an error saying, "We actually have to split them between four kids". The group asked questions when they were confused (e.g., "what do the numbers mean?"), co-constructed meaning through multiple exchanges, reevaluated their thinking, and revised their solution. Students also paid close attention to the term *equally* and understood they had to give the same amount of tamales to each kid. Guiding questions from the teacher can be used to facilitate authentic mathematical discourse where multilingual students can go deeper to clarify and negotiate their thinking (Kazemi & Stipeck, 2009). Teachers often ask guiding questions after students work together to solve a problem connected to the story. Students actively engaged in meaningful mathematical discourse because they were genuinely interested in the problem drawn from the book. The context of the story increased their motivation to solve the task, making the math feel relevant and enjoyable. This engagement was further supported by the teacher's intentional cultivation of a problem-solving culture, where students felt encouraged to share ideas, take risks, and collaborate.

Conclusion

This article contributes to the field of mathematics education by offering asset-based, culturally and linguistically responsive ideas for integrating multicultural children's literature into math instruction. Drawing on classroom-based examples, the article demonstrates how literature can serve as a powerful tool for mathematical thinking, discourse, and identity development. By integrating multicultural literature into math instruction, teachers can not only enrich students' mathematical understanding and language development but also help them develop a strong, positive math identity. It is important for educators to rethink how literature and math can work together to support multilingual students in becoming confident mathematicians who see themselves and their cultures reflected in the math they learn. Using children's multicultural texts (e.g., Table 1) to support students' math identities and problem solving, especially for multilingual learners, can result in greater math achievement. Using texts that highlight bilingual characters and communities can help develop students' identities as mathematicians as well as validate their cultural identities. Since most texts used in the classroom often do not reflect the experiences of students of color, educators should make a conscious effort in changing this. Using multicultural texts about math concepts gives learners space to ask their own questions, build confidence and curiosity, and make connections between stories, their lives, and the world around them. Further, these texts can be beneficial for promoting authentic mathematical discourse in the classroom.

Visit https://education.ucdavis.edu/building-students-academic-language-mathematics for resources, recommended book lists, and extensions for the classroom.

Table 1

Multicultural Texts That Can Be Used in Mathematics

Book Title and Author	Category (Attending to)	Grade Levels	Math Concepts
Too Many Tamales by Gary Soto	Culture, Language	TK-3	Estimation, counting, problem-solving
That's Not My Name! by Anoosha Syed	Culture	TK-2	Counting, comparing quantities, data collection, graphing, categorization
Areli is a Dreamer by Areli Morales	Culture	TK-4	Measurement of time, sequencing, estimation, unit conversions
Isabel and Her Colores Go to School by Alexandra Alessandri	Language	TK-2	Counting, sorting
Luna's Yum Yum Dim Sum by Natasha Yim	Culture, Language, Math	TK-2	Fractions (equal sharing and division)
Sir Cumference Series by Cindy Neuschwander	Math	2-6	Geometry, measurement, logic, fractions
¡Hasta las rodillas! Up to my Knees! by Grace Lin	Language	TK-1	Measurement, comparison
Fractions in Disguise by Edward Einhorn	Math	3-5	Fractions, equivalence, problem-solving
Spaghetti and Meatballs for All by Marilyn Burns	Math	TK-3	Area, perimeter, multiplication, division
¡Mira Abuela! Ni Elisi! Look Grandma! by Art Coulson	Culture, Language, Math	TK-2	Spatial reasoning
Matariki by Kitty Brown, Kirsten Parkinson	Culture, Language, Math	TK-3	Numbers, counting, geometry, measurement, statistics
If You Were a Kid Building a Pyramid by Lawrence Schimel	Culture, Math	TK-5	Measurement of time, geometry, measurement, ratios, proportions

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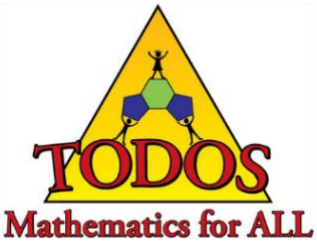
Discussion And Reflection Enhancement (DARE) Post-Reading Questions

1. Where are there opportunities to use multicultural literature in your math classroom?

2. How will you engage students in mathematical discourse using multicultural literature in order to promote problem solving?

3. Try this: Select a multicultural storybook from Table 1 in the article . Identify stopping points in the book where you may pause and discuss with students so that they understand the context or the mathematical features involved in the problem-solving activities.

4. Try this: Write a collaborative book with your class that represents the students' cultural and linguistic backgrounds and focuses on a math concept you are currently exploring.



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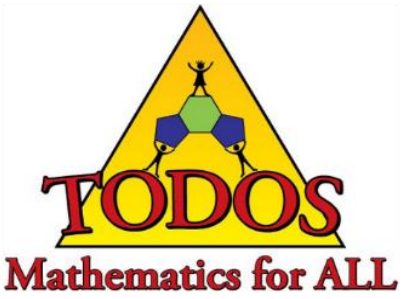

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