Draft California Mathematics Framework Shortchanges STEM

Introduction

In the midst of our ongoing COVID-19 crisis, you most likely haven't been made aware of the California Department of Education's plans to adopt a new 2021 Mathematics Framework. This framework will serve as the official template by which public school districts statewide orchestrate their mathematics programs for years to come, prescribing how educators, curriculum developers, and testing agencies alike will be interpreting the wording of the Common Core math standards. It strongly influences how your children's math classes will be run, and how students will be expected to take in and portray mathematical understanding throughout their most impressionable years. (https://www.cde.ca.gov/ci/ma/cf/)

There is a draft version currently under public review, for a period that runs until April 8th. Consisting of 13 chapters and over 800 pages of reading in total, it's a lot to take in. This is my summary of the proposal, opinionated though it may be, coming from the perspective of one who graduated through the San Francisco Unified School District, via Lowell High School, with top marks, at a time, nearly 40 years ago, when STEM (Science, Technology, Engineering, and Mathematics) career readiness was still the most essential goal of student tracking.

For reasons outlined here, I oppose this 2021 framework, and I urge everybody reading this, if you are similarly inclined, to respond to the online public review survey and express your concerns before the April 8th deadline. If adopted, I predict it will cause irreparable harm to our public's ongoing preparedness for STEM careers, resulting in unfathomable costs to all when our nation finds itself unable to advance or even properly maintain its highly technological, life-sustaining infrastructure.

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Equity vs. STEM Readiness

My biggest issue with the new framework is that, in its determination to bestow social justice and equity, it denounces existing exclusionary practices as "arbitrary or irrelevant," without ever honestly examining their necessity in the context of educating a workforce that will be tasked with the technological realities of the mid-21st Century. The framework makes a bold push for an equity-informed reimagining of our entire K-12 math education pathway, while redefining many important terms in ways that dissemble a fundamental disdain for STEM (Science, Technology, Engineering, and Mathematics) career preparation as an educational goal.

Perhaps the authors perceive that these STEM careers have been too inequitable for too long, based on their ongoing demographic numbers, or that they have been the drivers of too many systemic issues, now under much public antipathy, which the authors feel compelled to remove with haste. I make no argument with these concerns, but I do question how effectively the recommendations put forth in the draft framework will serve to remedy them.

Whatever the motivation for it, a careful reading of the framework shows no consideration of STEM readiness in the "math for all" pedagogy that it puts forth. This absence is made all the more alarming by the fact that the framework calls to do away with all tracking, acceleration, gifted programs, or any instruction that involves clustering by individual differences, without expressing any awareness of the impact these drastic alterations would have in preparing STEM-ready candidates. Both Algebra in 8th grade and Calculus in 12th grade would be slated to go. To justify the change, the framework grossly misrepresents the characteristics of gifted and talented students. (See Mischaracterization of Students, further below.)

Education research studies are cited throughout the framework document, and I have not had the time to review them in enough depth to characterize them accurately. I do perceive that they've specifically shied away from STEM readiness to support strong, positive conclusions regarding the interventions involved. I have yet to see a study in support of the framework that directly addresses the existing de-facto standards of STEM preparation, which are far more stringent than simply passing the general math courses or meeting the mastery targets set forth in the Common Core State Standards.

The Common Core math standards themselves state very clearly that they are not sufficient for STEM preparation, and I believe they were written this way to honor the known limitations existing in the education research upon which they were based. Throughout the 2021 draft framework, similar research conclusions are cited with no mention of any such limitation. Amid its calls to alter content, assessment, and grading, to the point of making the targeted practice of key skills entirely superfluous, it leaves no way to determine how well or how poorly the new general pathway is preparing its student cohort in this regard. No way to assess, and no way to alter course if things are going very badly.

For all its systemic issues, our highly-engineered, complex, interconnected, technological infrastructure now serves far too many of our fundamental needs to simply be abandoned or dismantled. The risk that we will find ourselves faced with an extinction of STEM-suitable candidates coming out of our public schools, as a direct result of this framework, is far too great. I need not spell out how bad such an outcome would be for equity.

Furthermore, by removing all the opportunities for our highest achieving students to prepare their way into suitable STEM pre-career pathways, those careers would remain available only to students coming from families wealthy enough to afford private enrichment. Such a move is all the more foolhardy in California, a state that is both economically and symbolically anchored by its technological innovation and leadership. Achieving equity in the STEM fields requires raising the reach of all who might rise to the challenge, not lowering the bar so far that few will be prepared for its stretches anymore.

Pedagogical Concerns

The framework authors seem to believe that a procedurally heavy and logically sophisticated approach to math, of the kind that is absolutely necessary for any level of STEM pre-career eligibility, can simply be provided later, when the students are attending college. There is much long-standing research indicating exactly the opposite, that students need to be exposed to these mathematical challenges early and often, if they are ever going to reach the very top levels.

I fear the issue would go even further than that. The framework tries to make math more accessible by diminishing the importance of subject content, loading the classroom with more exploratory activities centered on practicing visual and representational connections between "big ideas," rather than fleshing out the mathematical details pertinent to each sub-topic. When math is taught well and in a timely sequence, the “big ideas” emerge as a reasonable, straightforward, and nearly self-apparent framework, perceptible through common meanings and pattern forms that span across many distinct content topics.

Directing attention to the big ideas without first having honed better perception in detailed, well-practiced, symbolic terms provides little more than a blurred shadow of the subject. It is likely that such extensive work with these shadowy forms, rather than exposure to the math in subject relief, will hinder rather than enable math learning to high levels. Over time, this limited perception becomes the settled way of knowing. If it is too lacking in necessary fine detail, later learning will conflict with the embedded perceptions rather than complete them. The resulting hurdle in this regard is likely to be more exclusionary than any of the other inequities found in the existing multi-tiered pathway.

Instructional design that aims for the appreciation, performance, and retention of math content only in this broadest sense, though it may be more-readily and better received by a wider range of students, neither constitutes nor aids them in the matter of STEM preparation. Despite the authors' assurances that top-level facility with the content will arise from their approach, it's quite telling that the framework calls for a redefinition of terminology appearing in the Common Core standards, such as the word "fluency," to divorce the meaning from any performance-based considerations of response time or accuracy.

Whether the claims of success for all are deliberately misleading or well-intended encouragements having unintended consequences, any equity gains that are achieved in the course of putting forward this new curriculum will quickly fade when positive outcomes don't come to pass. The cause of yet another round of failed false promises and misinformation will be the ultimate takeaway for members of underserved communities who experience this.

Instead of acknowledging the importance of STEM careers, the framework authors make assertions about the mathematical relevance of the proposed curriculum pathway to STEM-adjacent and other influential non-STEM careers, those that will call for practitioners to be "users" of math. There is no clear indication that their sketchy, big-picture approach to learning math will be pertinent to the necessary mathematical work in these careers either.

The highly interconnected and technical nature of our industries and infrastructure call for more than just a passing appreciation of the modeling and connections between visual representations that illustrate the math so pleasantly. Now more than ever, students must learn how to discern the correct from the incorrect, the sound from the unsound, and they must do so in the midst of complex, sophisticated systems that have been engineered from the ground up in concert with abstract mathematical principles.

The very wording throughout the framework, relating to the purpose and importance of math, is dismissive of STEM. Page 3 of Chapter 1 reads, "Mathematics continues to play a role in how we conceive of our careers, evidence-based civic discourse, and policy-making, and the examination of assumptions and principles underlying action," as though the primary purpose of math is for civic discourse, policy-making, and political action. No mention of our medical, transportation, power, distribution, and sanitation systems infrastructures that now require constant maintenance and improvement.

There is also a disturbing call to political action in the wording and language of the framework, one which rings more of indoctrination than of math education. In its contrived attempt to build agency and inclusion in the name of equity, the subject of math is reduced to a cultural show-and-tell, with proficiency requirements giving way to tangential outcomes of mathematically mundane discussions and activities.

Mischaracterization of Students

The framework authors also make many gross overgeneralizations about groups of students, using blunt comparisons of mean values across groups to reduce a wide range of individual experiences down to a bolder but oversimplified problem statement. Nuances that would speak to other differences among and within these groups are blended away, even to the point of mischaracterization.

Gifted and talented students, those traditionally established as being in the top 2% or 3% of scorers on aptitude tests, are quite severely misrepresented in this way. Concern is expressed for the self-identity that emerges as a result of student labeling, positive or negative, and the pattern is blamed on a "fixed mindset," which the authors claim is the driving worldview behind any and all programs of early remediation, similar ability grouping, pathways offered in middle and high school to separate students by math aptitude and goals, and even the very concept of "giftedness" itself.

I am sympathetic to the assertion that overly-harsh remediation of students who learn math more slowly than expected likely leads to pernicious and identity-crushing mislabeling, and that the recommended changes would be a better solution in many of those instances. However, it's an absurd stretch from that position to invalidate all other ability-based tailoring of classrooms and math curricula, all the way up through grade 12, based on a blunt labeling of them as all holding the "fixed mindset" in their workings. It is possible to recognize the growth potential in every student still while exposing them to customized lessons that are better-suited to their learning needs at any given step along the way.

This particularly troublesome claim arises from the work of Jo Boaler, one of the 2021 Framework's authors. Boaler has often cited the research of Carol Dweck regarding the psychological benefits of "growth mindset" vs. "fixed mindset," but with misrepresentation of those findings in the context of giftedness. In overly-reductive fashion, Boaler classifies all recognition of giftedness and the pathways designed to cater to their needs as evidence of "fixed mindset," when the one has little to no bearing on the other. Carol Dweck has noted the distinction between giftedness and fixed mindset in her own work, a fact which Boaler has repeatedly chosen to overlook or outright deny.

On the matter of giftedness, the California Association for the Gifted has issued a statement and the following call to action, regarding Chapter 1 of the framework:

> Lines 414-488 on pages 15-17 must be completely removed, as they reinforce harmful myths about gifted math students (Sheffield, 2017). The lack of advanced curriculum and talent development services in mathematics, as described in this document, will further exacerbate the excellence gap in California and fails our advanced learners, with the greatest consequences for our students in urban, rural, and Title I schools and for our American Indian, Alaskan Native, Black, Latinx, Native Hawaiian, and Pacific Islander students (Gentry, Gray, Whiting, et al., 2019; Wright, Ford, Young, 2017). By offering advanced mathematics, reinforced by gifted and talented services, California ensures that its next generation of diverse, innovative producers are equipped with the conceptual foundation, critical thinking, and real-world problem-solving to effectively contribute as dynamic members of the workforce and as individuals who can address problems critical to the future of STEM.

Conclusion

For sake of brevity, I have only scratched the surface of all the issues I discovered through a detailed reading of the proposed 2021 Mathematics Framework, which are written up in more detail elsewhere. The framework calls for a fundamental alteration of the focus and presentation of mathematics, based on research that most often measures results against stated course rubrics or curricular outcomes, not the professional requirements of the industries to which the buildup of skills is ultimately aimed. Even when engagement is improved, the altered focus only superficially touches on the math that is likely to be needed for success in key career areas. The adequacy of its recommended reliance on such methods remains unestablished.

The framework also neglects to convey the importance of many STEM fields, for which its pedagogy is more clearly inadequate. The stricter mathematical requirements for STEM readiness are never mentioned, and the societal importance of these fields is downplayed. There is no indication that the new curriculum will achieve STEM-readiness, and fair reason to believe it will severely hinder all students in that regard. The following is a list of likely negative consequences that I foresee happening over the long term if the framework is adopted.

Likely Negative Outcomes

1. An over-reliance on engaging math investigations may actually conflict with the later development of top-level math skills.
2. Weakened and irrelevant assessments mean that educators cannot troubleshoot the curriculum's shortcomings.
3. Students who would have otherwise excelled in math will be bored by the approach and plateau.
4. A brain drain and funding drain from public schools, as higher-performing students flee to private schools.
5. Equity setbacks rather than improvements, due to increasing STEM career exclusion for students who come through this framework.
6. Students from families who can afford enrichment or private school will achieve better outcomes.
7. Delayed introduction to formal math will hinder all college students in mathematics.
8. More students will find themselves stuck in pricey remedial college math classes.
9. This will be yet another equity-minded program that ends up being blamed for worsened inequities down the road, with little benefit to show for itself.
10. Equity is better served by reforming existing pathways to be more accommodating of inter-group differences, without compromising career-relevant standards.
11. Poorly informed math will drive impactful public decisions in risky and harmful directions.
12. A lack of appropriate talent in our technical industries will render us unable to maintain current standards of living, with unforeseeable negative consequences.
13. Loss of adequately prepared students for STEM careers raises the risk of a catastrophic system failure of some kind.

Excerpts from the Framework Document

Chapter 2, Lines 674 to 681:

> Mathematics educators have an imperative to impart upon their students the argument that mathematics is a tool that can be used to both understand and change the world. Mathematics has traditionally been viewed as a neutral discipline, which has occluded possibilities for students to develop more personal and powerful relationships to mathematics and has led too many students to believe mathematics is not for them. A different perspective enables teachers to not only help their students see themselves inside mathematics but develop knowledge and understanding that allows them to use mathematics toward betterment in their worlds.

Chapter 2, Lines 88 to 96:

> Students must view mathematics as a vibrant, inter-connected, beautiful, relevant, and creative set of ideas. As educators increase access for students to engage with and thrive in mathematics and value the different ways questions and problems can be approached and learned, many more students view themselves as belonging to the mathematics community (Boaler & Staples, 2008; Boaler, 2016; Langer-Osuna, 2015; Walton et al, 2012). This community serves a diversity of learners more equitably, prepares students to think

mathematically in their everyday lives, and helps our society develop many more students interested and excited by Science, Technology, Engineering, Arts, and Mathematics (STEAM) pathways.

Chapter 1, Lines 122 to 129:

This mathematics pathway system, typical of many school districts, counters the evidence that shows all fifth graders are capable of eventually learning calculus, or other high-level courses, when provided appropriate messaging, teaching, and support. The system of providing only some students pathways to calculus, or statistics, data science or other high-level courses has resulted in the denial of opportunities [sic] too many potential STEAM students—especially Latinx and African American students. At the same time, arbitrary or irrelevant mathematics hurdles block too many students from pursuing non-STEAM careers.

Note: The evidence evaluates "learning calculus" by the criteria of achieving a passing grade in the class, and it makes no distinction with regard to the more stringent requirements of STEM-readiness. It is disingenuous to say that "denial of opportunities" exists, without specific consideration of whether or not such requirements are being met. Likewise, it cannot be established what makes the existing hurdles "arbitrary or irrelevant" without considering the actual level of competency necessary for successful pursuit of a career in each of these fields.

Chapter 1, Lines 206 to 226:

A fundamental aim of this framework is to respond [sic] issues of inequity in mathematics learning; equity influences all aspects of this document. Some overarching principles that guide work towards equity in mathematics include the following:

- Access to an engaging and humanizing education—a socio-cultural, human endeavor—is a universal right, central among civil rights.
- All students deserve powerful mathematics; we reject ideas of natural gifts and talents (Cimpian et al, 2015; Boaler, 2019) and the "cult of the genius" (Ellenberg, 2015).
- The belief that "I treat everyone the same" is insufficient: Active efforts in mathematics teaching are required in order to counter the cultural forces that have led to and continue to perpetuate current inequities (Langer-Osuna, 2011).
- Student engagement must be a design goal of mathematics curriculum design, co-equal with content goals.
- Mathematics pathways must open mathematics to all students, eliminating option-limiting tracking.
- Students' cultural backgrounds, experiences, and language are resources for learning mathematics (González, Moll, & Amanti, 2006; Turner & Celedón-Pattichis, 2011; Moschkovich, 2013).

- All students, regardless of background, language of origin, differences, or foundational knowledge are capable and deserving of depth of understanding and engagement in rich mathematics tasks.

Chapter 3, Lines 58 to 63:

> Fluency means that students use strategies that are flexible, efficient, and accurate to solve problems in mathematics. Students who are comfortable with numbers and who have learned to compose and decompose numbers strategically develop fluency along with conceptual understanding. They can use known facts to determine unknown facts. They understand, for example, that the product of 4 x 6 will be twice the product of 2 x 6, so that if they know 2 x 6 = 12, then 4 x 6 = 2 x 12, or 24.

Note: This redefinition does not say that students need to be able to apply the strategies accurately. The above reads “if they know 2 x 6 = 12,” but nowhere does it state that they are required to know these number facts. The definition goes on to specifically divorce any norms regarding speed or response time from this new definition of fluency.

Chapter 1, Lines 57 to 61:

> Mathematics continues to play a role in how we conceive of our careers, evidence-based civic discourse and policy-making, and the examination of assumptions and principles underlying action. All students are capable of making these contributions and achieving these abilities at the highest levels.

Note: It would appear to this writer that the lack of any mention about the reliance of our modern-day infrastructure on STEM-informed technologies here is a glaring omission. Either the authors believe the social relevance of these life-sustaining technologies to be lacking, or they cynically understand that it’s beyond the reasonable expectations of this framework to prepare students to that end.

Chapter 1, Lines 179 to 183:

> Research is also clear that all students are capable of becoming powerful mathematics learners and users (Boaler, 2019a, c). This notion runs counter to many students’ ideas about school mathematics. Most adults can recall times when they received messages during their school or college years that they were not cut out for mathematics-based fields.

Chapter 7, Lines 1743 to 1747:

> The lack of tracking or acceleration will allow all students to regard mathematics as a subject they can study and in which they belong. This vision for middle years mathematics is organized around Drivers of Investigation, so that all work provides a purpose to understand and explain, predict what could happen, or impact the future.

Chapter 1, Lines 247 to 250:

An important goal of this framework is to replace ideas of innate mathematics "talent" and "giftedness" with the recognition that every student is on a growth pathway. There is no cutoff determining when one child is "gifted" and another is not.

Chapter 8, Lines 121 to 124:

Many students, parents, and teachers encourage acceleration in grade eight (or sooner in some cases) because of an incorrect conclusion that Calculus is an important high-school goal. This approach relies of [sic] the false belief that Algebra I must be taken in grade eight in order for the student to reach a calculus class in grade twelve.

Chapter 1, Lines 415 to 419:

In previous versions of this framework, students who have shown higher achievement than their peers have been given fixed labels of "giftedness" and taught differently. Such labelling has often led to fragility among students, who fear times of struggle in case they lose the label (see, for example: https://www.youcubed.org/rethinking-giftedness-film/), as well as significant racial divisions.

Chapter 11, Lines 124 to 128:

Chapters 6, 7, and 8 set out an approach to mathematics teaching through big ideas, instead of narrow procedures, with many ideas for tasks that focus on big ideas throughout the grade levels TK–12. Assessments should match the focus on big ideas, with students receiving opportunities to share conceptual thinking, reasoning and work, that are assessed with rubrics, as set out in this chapter.

Chapter 11, Lines 96 to 102:

True measurements of learning reflect the need to assess students broadly in order to promote more equitable outcomes as well as more valid assessments of mathematical understanding. Recommendations for equitable teaching and assessing, with clear links between the pursuit of equity and the ways we assess students can be found in Feldman (2019) and DeSilva (2020). A particularly damaging assessment practice to avoid is the use of timed tests to assess speed of mathematical fact retention.

Chapter 8, Lines 130 to 142:

Second, the push to calculus in grade twelve is itself misguided. In Mathematical Association of America (MAA) and NCTM clarify that "...the ultimate goal of the K–12 mathematics curriculum should not be to get into and through a course of calculus by twelfth grade, but to have established the mathematical foundation that will enable students to pursue whatever course of study interests them when they get to college" (2012). The push to enroll more students in high-school calculus often leads to shortchanging important content that does not lead directly to success in the advanced placement calculus syllabus, which is significantly procedural. "In some sense, the worst preparation a student heading toward a career in science or engineering could receive is one that rushes toward accumulation of problem-solving abilities in calculus while short-changing the broader preparation needed for success beyond calculus" (Bressoud, Mesa, and Rasmussen 2015).

Chapter 2, Lines 285 to 295:

A range of different research studies throughout K–12 have shown the importance of visual thinking in mathematics (West, 2004; Alibali, & Nathan, 2012; Boaler, et al., 2016; Boaler, 2019). Researchers even found that after four 15-minute sessions of playing a game with a number line, differences in knowledge between students from low-income backgrounds and those from middle-income backgrounds were eliminated (Siegler & Ramani, 2008). All mathematical ideas can be considered in different ways—visually, through touch or movement, through building, modeling, writing and words, through apps, games and other digital interfaces, as well as through numbers and algorithms. Fingers have been shown to be particularly important as a visual and physical representation for students, enabling the development of important brain areas (Boaler et al., 2016).

Chapter 2, Lines 132 to 141:

Mathematics is a subject made up of important ideas and connections. Curriculum standards tend to divide the subject into smaller topics, but it is important for teachers and students to think about the big ideas that characterize mathematics at their grade level and the connections between them. Instead of planning teaching around the small topics or methods set out in the standards, or the chapters of textbooks, teachers can plan to teach the "big ideas" of mathematics (Nasir et al, 2014). Lessons designed around big ideas facilitate the linking of one or more Content Connections with Standards for Mathematical Practice, and with one of the Drivers of Investigation, as described in Chapter 1. (See for example big ideas across grades K–8: https://www.youcubed.org/wp-content/uploads/2017/11/Big-Ideas-paper-12.17.pdf.)

Chapter 3, Lines 72 to 77:

Fluency is more than the memorization of facts, procedures, or having the ability to use one procedure for a given situation. Fluency builds on a foundation of conceptual understanding, strategic reasoning, and problem solving (NGA Center & CCSSO, 2010; NCTM, 2000, 2014). To develop fluency, students need to connect their conceptual understanding with strategies (including standard algorithms) in ways that make sense to them.

Note: Connecting in ways that make sense to them is considered more important than being able to arrive at the correct answer. Explanatory talk about concepts they've been forced to memorize and regurgitate does constitute conceptual understanding, and even more so when they can't do even basic arithmetic on their own. Counting on their fingers, or on a number line is not an effective computational strategy.

Chapter 1, Lines 562 to 568:

This framework adopts the implicit understanding that all students are capable of accessing and mastering school mathematics in the ways envisioned in California Common Core

Standards for Mathematics (CA CCSSM). “Mastering” means becoming inclined and able to consider novel situations (arising either within or outside mathematics) through a variety of appropriate mathematical tools, using those tools to understand the situation and, when desired, to exert their own power to affect the situation. Thus, mathematical power is not reserved for a few, but available to all.

[Chapter 1, Lines 140 to 144:]

The new provision of a data science high school course, open to all students (not only those considered “advanced” in middle school), that can serve as a replacement for algebra 2, has the potential to open STEAM pathways to diverse groups of students, both through its engaging content and its openness to all students—as described further in Chapter 5, and Chapters 7 and 8.

Note: Further descriptions of the data science course, appearing in the referenced later chapters, make no mention of any potential to open STEAM pathways as indicated here.

[Chapter 2, Lines 70 to 77:]

Research conducting in preceding decades has produced a wealth of information showing that the highest mathematics achievement, understanding, and enjoyment comes when students are actively engaged—when they are developing mathematical curiosity, asking their own questions, reasoning with others, and encountering mathematical ideas in multi-dimensional ways. This can occur through numbers, but also through visuals, words, movement, and objects, considering the connections between them (Boaler, 2016, 2019; Cabana, Shreve & Woodbury, 2014; Louie, 2017; Hand, 2014; Schoenfeld, 2002).

[Chapter 1, Lines 145 to 149:]

Mathematics education can also create the levels of understanding that can launch student action, both locally and globally. While every level of schooling must focus on providing access to mathematical power for all students, changing the high-school level mathematics remains a critical component to opening mathematics doorways for all students.

[Chapter 2, Lines 957 to 998:]

The open question, “What does this mean?” could potentially go in many possible directions, allowing students to bring their own noticings, curiosities, and concerns to bear on the problem. As depicted in the image below, the students in this particular classroom came to notice the role of gender in the mathematics problem.

As the third and final prompt within the exercise, Ms. Ross asks students, “Why does this matter?” This time, she is asking students to identify perspectives and points of view in the text, and encouraging them to look for the “silences” in texts. Students are able to take what they noticed and named – in this case, how gender played out in the problem – and consider its implications, enabling critical thinking. In doing so, Ms. Ross’ question asks students to grapple with: What prior knowledge and experiences aside from mathematics is needed? Whose lived experiences are not included?

During classroom discussion, several questions and concerns arise as a result from their conversations: (see Figure 3):

- What constitutes boys' things and girls' things?
- Problems with girls' names provide context related to looking pretty, being helpful, and being a homemaker.
- Problems with boys' names focus on sports and competition.
- Playing sports is seen as a boy's thing while playing house is a girl's thing.
- Are certain things—toys, games, activities, etc.—the sole and primary preserve of either girls or boys?
- Are there word problems about ribbons, cooking, or knitting that use a boy's name?
- Do these word problems really matter in real life? Do they represent mathematical calculations needed to engage in daily life?

Students' Mathematical Investigations

The word problem analysis serves as a springboard for students to investigate their own questions. One student asks, "Are there word problems that have a male knitting a scarf, cooking, cleaning?"; and another ponders, "Does the textbook always use girl names for girl stuff and boy names for boy stuff?" Lastly, another student asks, "Are there word problems that challenge gender stereotypes?" When examining the entire textbook, the students noted that there were a few instances of gender-fluid problems (e.g., David's dad baked a dozen cookies to share with him, his sister, and his mom); however, the problem continued to conflate gender with a heterosexual identity. The class could not find problems involving non-nuclear families (e.g., two moms, a single dad) or gender nonconforming characters (e.g., John cutting ribbon). Ms. Ross has students notice these patterns, but also asked students to question why certain items (e.g., toys, activities, careers) are perceived as being "for" only girls or boys, and the implications for these assumptions. She continues to engage her students by asking, "Why does this matter? Who does this privilege? Who is silenced?"

Chapter 2, Lines 713 to 719:

In the example that follows (from Diez-Palomar & Lopez Leiva, 2018), a group of students explored their family's immigration experiences through a measurement lesson on the topic of unit conversion, specifically between the US system and the metric system. Many of the students had experienced immigrating with their families to the US or knew relatives who had, as well as had family members living on the other side of the Mexican border. Through map explorations and a series of discussions, students used and expanded their math skills,

Chapter 1, Lines 419 to 422:

In California in the years 2004–2014, 32 percent of Asian American students were in gifted programs compared with 8 percent of White students, 4 percent of Black students, and 3 percent of Latinx students (https://nces.ed.gov/programs/digest/d17/tables/dt17_204.80.asp).

Note: A more telling statistic would be the percentage of practicing professionals in STEM fields, broken out by race and gender, who attended gifted programs, relative to percentages of those in each demographic who came through non-accelerated pathways with top grades. Questions about the perceived relevance of the preparation they received would also be quite valuable.

Chapter 1, Lines 234 to 235:

> Fixed notions about student ability, such as ideas of "giftedness," have led to considerable inequities in mathematics education.

Chapter 1, Lines 247 to 250:

> An important goal of this framework is to replace ideas of innate mathematics "talent" and "giftedness" with the recognition that every student is on a growth pathway. There is no cutoff determining when one child is "gifted" and another is not.

Chapter 1, Lines 253 to 256:

> Stanford University psychologist Carol Dweck and her colleagues have conducted research studies in different subjects and fields for decades showing that people's beliefs about personal potential changes the ways their brains operate and influences what they achieve.

Chapter 1, Lines 562 to 568:

> This framework adopts the implicit understanding that all students are capable of accessing and mastering school mathematics in the ways envisioned in California Common Core Standards for Mathematics (CA CCSSM). "Mastering" means becoming inclined and able to consider novel situations (arising either within or outside mathematics) through a variety of appropriate mathematical tools, using those tools to understand the situation and, when desired, to exert their own power to affect the situation. Thus, mathematical power is not reserved for a few, but available to all.

Chapter 1, Lines 129 to 132:

> Mathematics education must support students whether they wish to pursue STEAM disciplines or any other promising major that prepares them for careers in other fields, like law, politics, design, and the media.