

## CHAPTER 2

# BEYOND NUMBERS AND EQUATIONS

### What Is Mathematics?

In this chapter we will:

- Consider what mathematics means and how it is used.
- Explore research around student views of mathematics.
- Illuminate important but underrepresented areas of mathematics.
- Reflect on how you can challenge traditional views of what mathematics is.

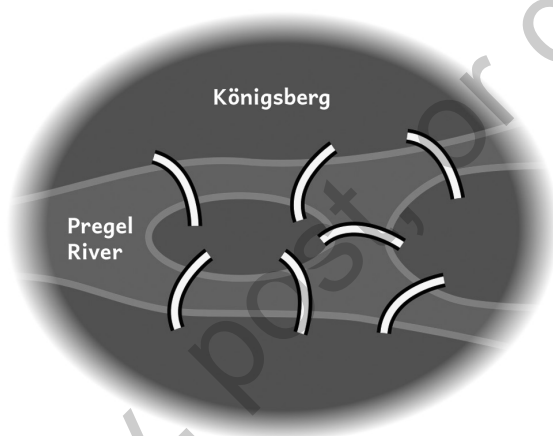
### WHAT COMES TO MIND WHEN YOU THINK OF MATHEMATICS?

One reason many people are comfortable saying they are *bad at math* is that they are thinking of mathematics in a very narrow way, focused on only those topics that they may have struggled with in school rather than on all the mathematics they undertake each day. Take a moment to consider the question *What is mathematics?* What ideas, words, and images jump to mind when you try to define the subject? For many, the answer revolves around numbers, computation, and equations. Images conjured are often of a chalkboard covered in symbolic language or of one's own experiences in a mathematics classroom. Less often do people think of their day-to-day lives and the mathematics that comprises so much of what they experience, or of the mathematics that underlies so many facets of our social, natural, and technological world. Yet, when you have a few errands to run, and you set out to determine the best route to take in completing them, you are engaging

in mathematics. You may want to ensure you don't double back on any of the streets you have already traveled, if possible, to go about your errands more efficiently and save time. You might ask if it is possible to create a path that allows you to make it to each of your stops without crossing the same street more than once. These kinds of considerations are part of a field of math known as graph theory. Such questions have been studied for a long time.

## The Seven Bridges of Königsberg

**Figure 2.1** • *The Seven Bridges of Königsberg*



SOURCE: Diagram of Seven Bridges of Königsberg. (2020, September 13). In *Wikipedia*. [https://commons.wikimedia.org/wiki/File:7\\_bridges.svg](https://commons.wikimedia.org/wiki/File:7_bridges.svg); labels have been added. CC by 3.0 (<https://creativecommons.org/licenses/by/3.0/>)

The city of Königsberg in Prussia (what is now Kaliningrad, Russia) comprises land on both sides of the Pregel River as well as two large islands (Kneiphof and Lönse) that were connected to each other and to the mainland portions of the city, as shown in Figure 2.1, by seven bridges. Those who lived there wondered whether it was possible to walk through the city by crossing each of the bridges once—and only once. Known as the Seven Bridges of Königsberg, the question was resolved in 1736 by mathematician Leonhard Euler, who determined it was impossible to walk over each of the bridges precisely one time. In doing so, he created the field of graph theory, an incredibly rich area of mathematics with applications to many societal realities, as we will discuss later in this chapter. Does this example fit into your conception of what mathematics is?

## WHAT IS MATHEMATICS, REALLY?

Mathematics, when understood deeply, transcends numbers, equations, and computation. Keith Devlin, a Stanford University professor and National Public Radio's *Math Guy*, defines it as the study of patterns. Specifically, he writes:

The mathematician identifies and analyzes abstract patterns—numerical patterns, patterns of shape, patterns of motion, patterns of behavior, voting patterns in a population, patterns of repeating chance events, and so on. Those patterns can be either real or imagined, visual or mental, static or dynamic, qualitative or quantitative, utilitarian or recreational. They can arise from the world around us, from the pursuit of science, or from the inner workings of the human mind. Different kinds of patterns give rise to different branches of mathematics. For example:

- Arithmetic and number theory study the patterns of number and counting.
- Geometry studies the patterns of shape.
- Calculus allows us to handle the patterns of motion.
- Logic studies patterns of reasoning.
- Probability theory deals with patterns of chance.
- Topology studies patterns of closeness and position.
- Fractal geometry studies the self-similarity found in the natural world.

(Devlin, 2012, p. 3)

Devlin notes further that in the mid-19th century mathematicians used mathematics to study mathematics itself and adopted a new conception of mathematics where the primary focus shifted away from calculation and computing answers to formulating an understanding of abstract concepts and relationships. “Mathematical objects were no longer thought of as given primarily by formulas, but rather as carriers of conceptual properties. Proving something was no longer a matter of transforming terms in accordance with rules, but a process of logical deduction from concepts” (Devlin, 2012, pp. 5–6). He refers to this new conception of mathematics as a revolution that “completely changed the way mathematicians thought

of their subject” but adds that “for the rest of the world, the shift may as well not have occurred” (Devlin, 2012, p. 6). The reason for this is that the mathematics most people are exposed to in their schooling is very focused on computation and calculation. You are taught to identify types of problems and then given procedures to solve these problems. Devlin notes that most of the mathematics used today was developed in the last 200 years, but virtually none of what is taught is from even the past 300 years. As a result of this, many are “unlikely to appreciate that research in mathematics is a thriving, worldwide activity, or to accept that mathematics permeates, often to a considerable extent, most walks of present-day life and society” (Devlin, 2012, p. 2). I would argue and have already argued in this text that it does not need to be this way entirely. We can highlight the evolving nature of mathematics and talk about open problems in a way that allows individuals to see the creative and evolving nature of the field.

## HOW DO STUDENTS VIEW MATHEMATICS?

A traditional view of mathematics as focused on numbers and equations can be found among students as well, even among those studying mathematics itself. One way to change this is to invite mathematicians and others in math-related careers into the classroom to share mathematics that may not typically be covered in the K–12 curriculum. In the fall of 2009, a colleague of mine, Dr. Rishi Nath, and I did just that at the college level. We started a mathematics circle called the York Tensor Scholars at York College, City University of New York (CUNY). It had two goals: (1) introducing varied mathematical topics to challenge the traditional views of mathematics and how it is defined and (2) challenging perceptions of who can and does excel in mathematics. We invited speakers, almost exclusively women, whose work focused on a broad range of mathematics and covered areas not typically introduced in K–12 curriculum or undergraduate courses for math majors. As an example, Dr. Amanda Redlich, then a postdoctoral researcher at Rutgers University and now an assistant professor at the University of Massachusetts, gave a talk about how knitting can be used to model three-dimensional surfaces. In her talk, we learned about the Kitchener stitch, which in knitting is used to join (graft) knitted pieces together seamlessly, as in a sock with a seamless toe. Dr. Redlich uses the stitch and knitting in general to create models of surfaces with various properties. Dr. Diana Thomas, a professor of mathematical sciences at the U.S. Military Academy, gave a talk about her creation of mathematical models to study changes in body composition during weight change. We also invited Dr. Vrunda Prabhu, then a professor at Bronx Community College, to give a talk about

mathematics and creativity. These examples feature mathematics that is being done in the present day but that, typically, does not enter the discussion of the subject at the school or collegiate level.

Additionally, there were talks on graph theory, number theory, cryptography (making and breaking codes), the mathematics of Wall Street, and the mathematics of the steel drum, and even one where the researcher applied the way lightning bugs align their blinking to the synchronization of clocks. The topics were incredibly diverse. At the program's conclusion, I conducted a study of the program that included surveys of those who had attended our events as well as interviews of some of the students who participated in the program. Student survey responses confirmed our belief that students would find these topics both interesting and new. In fact, students often remarked that the mathematics they were being exposed to was different from that to which they were accustomed in their coursework.

However, despite exposure to these very different topics in mathematics, at the conclusion of their time in the program, those students who were interviewed still clung to very traditional beliefs about what mathematics is. When asked to define it, most students linked mathematics to numbers, equations, and formulas, as evidenced by responses such as the following:

- *Numbers. What else is math? It's the study of numbers and how they relate to each other.*
- *It's a bunch of numbers and formulas put together.*

Of the ten students interviewed, there were only two whose answers showed a less narrow focus. One student described mathematics as “the foundation” and when pressed added that “mathematics is the foundation of everything.” Another student described a change in their view of mathematics. This student explained that prior to participation in the group, they held a view of mathematics as consisting of equations to be solved, but “Now I'd say that mathematics is the study of patterns.” It was this type of progression that I had hoped to see in the students who participated in the program, but it manifested itself in only one of the students interviewed. Why might that be?

Given that the featured topics challenged the traditional perceptions of mathematics and that the students lacked familiarity with such topics, one might expect that students' own views of mathematics would be broadened. Yet, in terms of beliefs about mathematics, most students still clung to the traditional definition. This is a very common outcome but not one we

expected from a group of students who over the course of several years had been exposed to much more than just numbers and equations through the work of mathematicians currently in the field. However, it seems that years of schooling that prioritized numbers and algebra could not be undone in a program where students spent an average of two years. We must start challenging traditional conceptions of mathematics and building a broader set of mathematical experiences for students from a *much* earlier age.

To challenge traditional views of mathematics in the classroom, start a conversation with students about what they perceive math to be and what math really can be.

Try using the following prompts to get students talking about mathematics and their experiences with it.

- The best thing about math is . . .
- The worst thing about math is . . .
- Learning math is like . . .

Consider the responses you obtain and how you might work with them. Do they point to negative or stereotypical views of mathematics? If so, consider challenging these perceptions by using more diverse problems or by bringing in individuals who use mathematics in their lives to share that mathematics with students. Do they point to stereotypical views of mathematicians? If so, consider bringing in the stories of diverse mathematicians from underrepresented groups through readings, posters, and films. Do they point to negative views around the learning of mathematics? If so, consider activities that encourage productive struggle and attempt to build student confidence in addition to mathematical competence. Are student answers full of creativity and positive views of mathematics, mathematicians, and the students themselves as doers of mathematics? Some surely will be. Build on these by highlighting them often. Use students' own words to remind them of the positive when it comes to mathematics. Hang their words on your walls and reference them frequently.

## THE FOCUS OF K–12 MATHEMATICS AND WHAT GETS LEFT OUT

There are consequences to the narrowing of mathematics to numbers and equations. One of these is the fact that students leave their formal schooling with an incomplete view of what mathematics is and of the reality that it

is constantly growing and evolving. This may mean that individuals who otherwise would have been attracted to the field, or who would have seen the field as a living one, may be put off by the focus on numbers and equations and thus shy away from it. This may result in individuals not engaging with it beyond what is required and even shying away from the topic as adults, though there exists an abundance of what are called *popular mathematics* books written for general audiences with no presumption of mathematical background that bring the subject to light and show the connections between mathematics and other fields in exciting ways. Lack of exposure during K–12 schooling to perfectly valid, beautiful, and in many cases useful mathematics that lies somewhat outside the field of algebra may lead many to think of this vibrant field as dull and cold. It might also lead some to believe they are *bad at math* when in reality they may struggle in an area commonly taught in school but excel in other areas that are often given less time or left out completely.

### Resources: Popular Books That Connect Math to the Real World

Ellenberg, J. (2015). *How not to be wrong: The power of mathematical thinking*. Penguin.

Fry, H. (2015). *The mathematics of love: Patterns, proofs, and the search for the ultimate equation*. Simon & Schuster.

Goodreads. (2022). *Popular mathematics books*. <https://www.goodreads.com/shelf/show/popular-mathematics>

Parker, M. (2021). *Humble pi: When math goes wrong in the real world*. Penguin.

Suzuki, J. (2015). *Constitutional calculus: The math of justice and the myth of common sense*. JHU Press.

As an example of the curricular focus I am talking about, at the end of kindergarten my daughter came home with several workbooks that she had used during the year in her class. One of these was a math workbook. I noticed that in most of the workbooks there were some pages that had not been completed, and I decided we would complete them during the summer. Upon opening her mathematics book, I was pleased to see that almost every topic had been covered. Actually, only one had not been touched. All the content that had to do with numbers (counting, place value, decomposition, relative size, etc.) and with equations (numeric equations involving addition and subtraction as well as word problems that could be solved using these equations) had been completed. The one topic that had not been addressed



was geometry. Specifically, content focused on shapes and their properties along with three-dimensional solids and their properties was skipped. A review of mathematical workbooks geared to young children reveals that geometry and other topics such as time, money, and sequencing tend to be found at the back of the book while content related to numbers and equations comes up front. Even in the kindergarten curriculum, long before students see advanced mathematics, the bias toward numbers and equations is clear. A review of the Common Core State Standards for Mathematics (Common Core State Standards Initiative, 2021) reveals the majority of standards in Grades K–8 focus on number and operations, operations and algebraic thinking, and expressions and equations. There is much less of an emphasis on geometry, probability, and statistics and virtually no topics in discrete mathematics, a rich area in the field that we will revisit later in this chapter. Likewise in Canada, a comparison of the Common Core State Standards to the Ontario content expectations, the Québec Essential Knowledges, and the Western and Northern Canadian Protocol curriculums conducted by the National Council of Teachers of Mathematics (2013) show, similarly, a focus on algebra, number sense, and numeration while showing a lack of discrete mathematics topics. If anything, less geometry is covered in the Canadian standards compared to the American ones, though there seems to be more of a focus on measurement. It is interesting to note that in 2020 the mathematics standards adopted in Ontario included financial literacy in the curriculum for Grades 1–8 (Ontario Ministry of Education, 2021). Specifically, it was stated that students would understand the value of money over time, learn financial well-being, and work on creating and managing budgets. At the high school level, the focus in schools across the United States and Canada is on algebra, although there is more geometry than in the younger grades. There are virtually no topics in discrete mathematics—including in election theory, which feels necessary for students in a democratic civil society. Similarly, there is little, if any, financial mathematics. Probability and statistics, though included in the Common Core State Standards and in the various standards documents across Canada’s provinces, do not get a deep treatment.

Making matters worse is the fact that in many areas, fewer than four years of math are required at the high school level. Canadian requirements vary by province, with most requiring three or four years of mathematics. In the United States, most states require three years, but some, such as California, require only two. What this typically means is that students who struggle the most tend to not take mathematics beyond the required number of



years (except to repeat a course they did not pass), which means that those needing the most help in the subject take the least mathematics courses and are often not exposed to the subject in the year preceding college, making it difficult for them to be successful in their entry-level mathematics course. In low-performing schools, it is common for an algebra course to be spread out over two years and for the two years to be coded differently so that students get credit for two years of mathematics even though they are being exposed to what is typically taught in a one-year course. Even after taking geometry in their third year, these students have completed the course requirement for mathematics but have studied the equivalent of only two years of high school mathematics, impacting their ability to be admitted to and do well in college. With a focus on algebra in preparation for calculus, many students leave high school with only a surface-level understanding of other branches of mathematics.

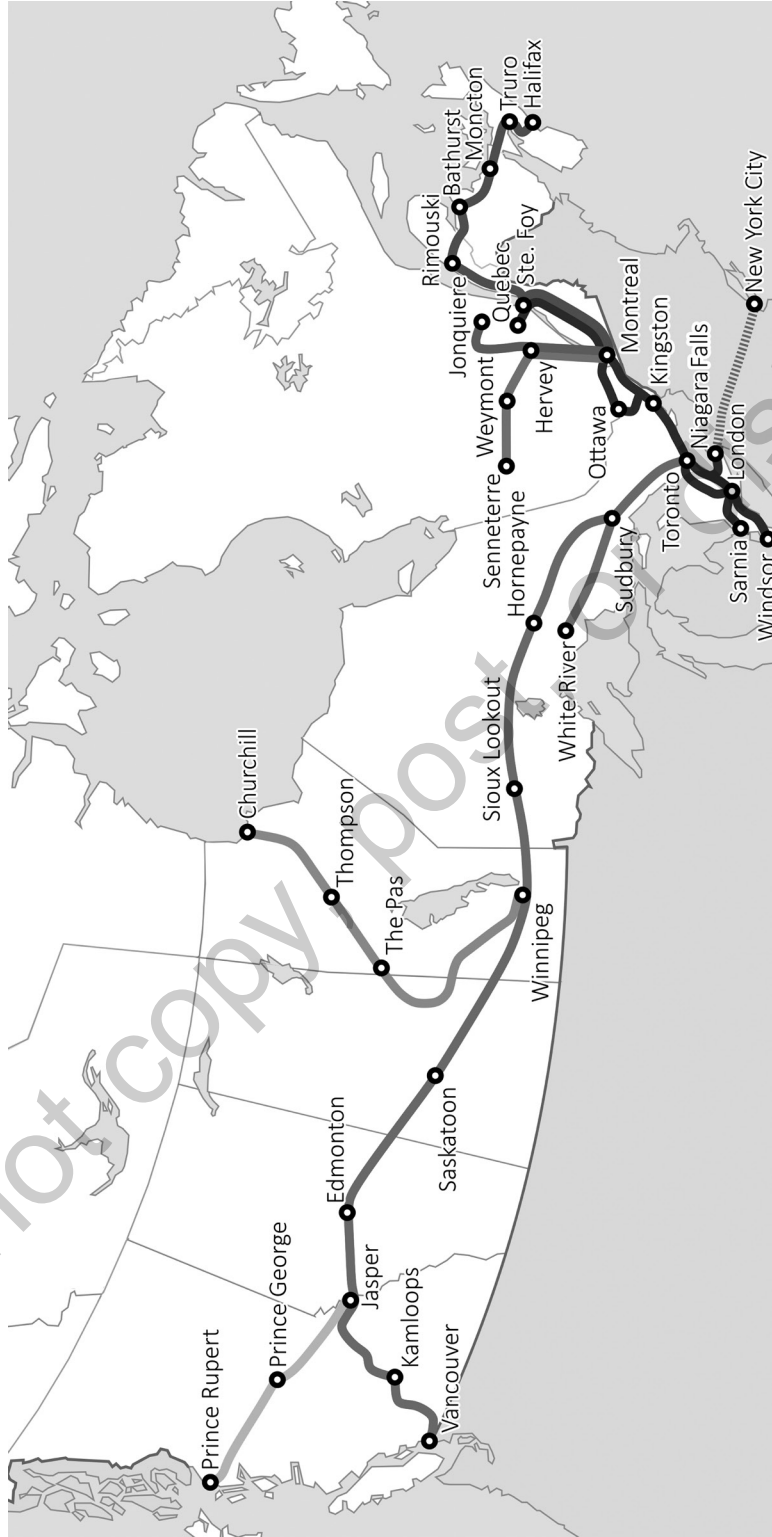
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These include discrete mathematics, financial mathematics, and statistics. Additionally, data science, which aims to provide insight from large data sets that are increasingly prevalent in our social world, is increasing in importance and has been proposed as part of California's K-12 math framework. These areas contain valuable mathematical content that can be applied across numerous topics.

### The Value of Discrete Mathematics

As an example, in discrete mathematics students study graph theory. A graph is a collection of vertices, some of which are connected to others by edges (sometimes directed and sometimes without a direction). One example of this is a subway map: The vertices are the subway stations where the trains stop; trains that you can take from one station to the next are connected by an edge; some stations are hubs that connect multiple train lines. These graphs can be used to visually describe the flight paths of airplanes, the connections between major freeways, and more, facilitating efficient travel and ensuring that both individuals and goods can make it quickly and safely to the desired location. For example, see the Canadian rail map in Figure 2.2.

Figure 2.2 • Canadian Rail Map



SOURCE: Stepney, C. (2019, February 1). VIA network map 2019. In *Wikipedia*. <https://en.m.wikipedia.org/wiki/File:VIANetworkMap2019.png>; CC by 4.0 (<https://creativecommons.org/licenses/by/4.0/>)

Similarly, you can create a graph of this type to model the spread of disease. If person A gives the disease to person B, there is a directed edge from A to B. Thus, graphs can be used for contact tracing such as was implemented in response to the COVID-19 pandemic. Directed graphs can also be used to model social networks. Individuals with many followers have many edges leading into the vertex, while those who follow many people have many edges leading out.

Discrete mathematics also includes election theory. Dr. Joseph Malkevitch (2008), professor emeritus at York College, CUNY, showed incredibly that using the same set of ranked ballots (where each voter is asked to rank the candidates in order from their favorite to their least favorite) could produce five different winners in a five-person race depending on the method used to evaluate those ballots. In the United States, it is often the case that the candidate with the most votes wins (plurality voting), but there are cases, such as the Electoral College, where this is not true. Every political party in Canada uses ranked voting to elect its leaders. Here people indicate their first, second, and third choice. Initially, all the first choices are added, and if there is a majority, that person wins. If not, the candidate with the fewest votes is eliminated, and those ballots where that person was ranked first now get transferred to whomever was ranked second. The process repeats until someone has a majority. There are also races where the candidate with the most votes does not necessarily win certain elections unless they have more than a certain percentage of the vote. Thus, in a race with many candidates, there may need to be a runoff election where a subset of the top candidates face off against each other. In the United States, the election of a president relies on the use of the Electoral College. Students would benefit from learning about this, especially given the fact that many if not most will be expected to participate in the political life of their country as voters themselves.

### Resources: Discrete Mathematics

DeBellis, V. A., Rosenstein, J. G., Hart, E. W., Kenney, M. J., & House, P. A. (2009). *Navigating through discrete mathematics in prekindergarten–Grade 5: Principles and standards for school mathematics navigations*. National Council of Teachers of Mathematics.

Hart, E. W., Kenney, M. J., DeBellis, V. A., & Rosenstein, J. G. (2008). *Navigating through discrete mathematics in Grades 6–12: Principles and standards for school mathematics navigations*. National Council of Teachers of Mathematics.

## THE INCREASING VALUE OF STATISTICS

The proliferation of numeric data in every aspect of social life places an additional burden on citizens with respect to voting. Two candidates with very different plans when it comes to taxes may both argue that their plan lowers taxes for the middle class while generating sufficient revenue to sustain these cuts over several years. Ascertaining the validity of each claim, as well as understanding the impact of such policies on one's own circumstances and on society, requires a good deal of mathematical fluency. Conflicting claims from opposing candidates are commonplace, and being able to examine these critically is essential to being able to vote for the candidate who most aligns with one's own views of major issues.

It is increasingly the case that candidacies in the modern era can be won or lost based on the unemployment rate, the crime rate, or the Dow Jones index. Our multitudes of numerical indicators summarize the complex economic, political, and social health of the country, and citizens need to be able to decode and decipher this modern day "political arithmetic." (Cohen, 2003, p. 7)

In addition, increasingly complex visual displays of data are being incorporated into newspapers, magazines, and other media outlets to shed light on our political systems, yet without the ability to properly make sense of them, such information becomes confusing rather than clarifying.

There is currently a move toward offering both Advanced Placement (AP) Calculus (what had been the traditional offering) and AP Statistics in schools. While this trend is a welcomed one, the only students benefiting are those who have access to AP courses, and there is an underrepresentation of Black and Latinx students in these courses. As such, Black and Latinx students are less likely to be exposed to the rigorous study of statistics. Additionally, AP Statistics has traditionally been taught as a theoretical course, with little direct intentional applications to current societal realities. While it may be a good theoretical course, it has not traditionally been taught in ways that highlight how statistics can be used to understand, analyze, and explore the social realities of the current day.

### Resources: Statistics and Data Science

American Statistical Association & National Council of Teachers of Mathematics. (2022). *Statistics Teacher publications*. <https://www.statisticsteacher.org/statistics-teacher-publications/>

This Is Statistics. (2022). *Statistics resources for educators*. American Statistical Association. <https://thisisstatistics.org/educators/>

## The Value of Financial Mathematics

Another beneficial area of mathematics that is often left out of the curriculum is financial mathematics or, as some call it, financial literacy. While it may seem that financial mathematics is basic and that students can pick it up as they go, this is not necessarily the case. Compound interest, annuities, stocks, and paying off one's credit card rely on mathematics that includes geometric sequences, exponential and logarithmic functions, and even calculus. As such, explicit instruction in financial mathematics would benefit students. Individuals from wealthier backgrounds are more likely to invest in the stock market and have a retirement plan, as well as to have set up other methods of both savings and generating income from those savings. Their children, through lived experience, are being taught the value of these investments. Individuals from poor and working-class backgrounds are not nearly as often being taught these lessons from lived experiences. Further, they are more likely to be in debt. Granted, teaching financial math won't necessarily get folks out of debt. There exists a myriad of reasons why wealth is concentrated among so few. We certainly need to think through the policies that created the wealth disparity we see in our society and institute social policies that promote fair wages and ensure jobs with good benefits while reconsidering our tax structure so that everyone pays their fair share. However, having a solid understanding of how wealth works and the mathematics behind various financial realities can help individuals to make better financial decisions as well as advocate for policies and programs from which they may benefit.

### Resources: Financial Mathematics

Andal, W. (2021). *Finance 102 for kids: Practical money lessons children cannot afford to miss*. Gatekeeper Press.

FINRA Investor Education Foundation. (2022). *Resources for educators*. <https://www.finrafoundation.org/people-we-help/resources-for-educators>

Stephenson, A. (with Mills, L.). (2020). *Teach your child about money through play: 110+ games/activities, tips, and resources to teach kids financial literacy at an early age*. SimplyOutrageousYouth.org

## BALANCING ALGEBRA AND OTHER AREAS OF MATH

At present, in a society that values algebra so heavily and relies on it for graduation requirements, entrance into college, and beyond, not teaching students algebra puts them at a disadvantage. In fact, given that algebra is a predictor of future success, Moses and Cobb (2001) consider the access to high-quality upper-level mathematics, including algebra, for Black students as important as Black people earning the right to vote during the civil rights movement. They see it as a civil right. Further, that we should be taught only what we will use—the principle of utilitarianism in education—is difficult to support. We are never truly sure of what we will need to know going forward.

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More than this, however, is the idea of well-rounded individuals whose broad understanding of a wide range of subjects allows them to appreciate and readily engage with the world around them.

There is value and merit to the idea that we can reduce the focus on algebra to expand students' knowledge of mathematics be it quantitative literacy, financial mathematics, discrete mathematics, statistics, data science, or other areas whose study might broaden students' views of what mathematics is. This may also introduce students to topics that they would not otherwise see while highlighting the ways that mathematics connects to their lives. With this connection clear in their minds, it might be harder for individuals to buy into the *bad at math* trope.

When we move the focus, even just slightly, away from algebra, we find there is room in the curriculum for other perfectly valid and useful mathematics that can benefit students as they find their way in our social world. We should find ways to bring some of these areas into the classroom while pushing for changes to state-mandated curricula that value algebra and number sense over all other fields. There is room for a more inclusive treatment of all mathematics has to offer. Expanding what most individuals see as mathematics by ensuring that students are exposed to more varied mathematical topics might lead more people to realize that they do enjoy



doing mathematics. What they think of as mathematics would broaden to include topics that might attract them.

## Rethinking Calculus

The curriculum, as it stands, focuses on algebra with the eventual goal of calculus. AP Calculus is one way students position themselves for entry into college and obtain college credit. A score of 3 on the exam is usually accepted for college credit. However, access to these classes is limited for students from marginalized communities. Specifically, Black students represent just 8.8% of exam takers and 12.3% of those who scored a 3 or higher (Jaschick, 2019). Indigenous students account for less than 1% of exam takers and less than 1% of those scoring a 3 or above. The numbers are more encouraging for Latinx students (25.5% take the exam with 23.6% earning a 3 or above). If the eventual goal of mathematics is proficiency in calculus, then our most vulnerable students are being left out. This makes it difficult for them to succeed in science, technology, engineering, and mathematics (STEM) fields going forward. Think of the mathematical advances we miss out on as a society because some students are not given the opportunity to take courses that position them to pursue STEM fields. It isn't just the students themselves who miss out; it is all of us.

Recently, there has been some movement away from calculus as the solitary end goal of study in mathematics, and efforts at de-tracking mathematics education are underway. As an example, with the shift to the Common Core State Standards for Mathematics, and the resulting shifts in rigor and topics in the eighth-grade standards in particular, the San Francisco Unified School District eliminated accelerated mathematics courses in middle and high school mathematics. All students take a common math sequence of heterogeneously grouped classes in middle school and the first two years of high school. No longer is algebra offered in eighth grade (which positioned only those who had access to it more favorably in future studies), but rather all students take it in ninth grade and geometry in 10th grade. Going forward in their studies beyond algebra, students choose math courses based on their interests, including a broader array of advanced courses. Shifts in mathematics pathways at the high school level are also underway as part of the Catalyzing Change initiative of the National Council of Teachers of Mathematics. In this way, multiple paths toward the completion of mathematics requirements are being developed, affording students more choice and creating a more equitable system. No longer will calculus be the only way through.



At the college level, calculus is a course that students typically struggle with and one that has been used to weed out students from STEM programs. Seeing this as a problem, faculty in the life sciences at the University of California, Los Angeles, developed a two-semester calculus sequence that covers the typical content but does so while emphasizing its connection to biology and physiology (Burdman, 2022). Students who took the course received better grades in subsequent science courses than those enrolled in the traditional calculus sequence, and student interest in the content doubled. In a similar example at Ohio's Wright State University, traditional prerequisites for calculus were replaced with a contextualized math class that focused on real-world problems in engineering (Burdman, 2022). Here it was found that the course was particularly beneficial to students from historically marginalized communities in mathematics including Black and Latinx students. It might be time that we think about how to bring contexts into mathematics teaching that increase student interest while also making clear how the mathematics connects to our social world.

## WHAT CAN YOU DO TO CHALLENGE THE BELIEF THAT MATHEMATICS IS JUST NUMBERS AND EQUATIONS?

A common refrain from educators is that the curriculum they are expected to teach is already so packed, there is no time for other topics. But these topics can be integrated in small ways and in larger ones. Consider the following:

- Ask students to solve some problems using various methods—geometrically, acting it out, describing it in words, using pictures, and so on—not just algebraically or numerically.
- Use problems from diverse areas of math.
- Fill your classroom with representations of diverse mathematics (see more in Chapter 3).
- Incorporate a problem of the week drawing from diverse areas in mathematics.
- Incorporate games that focus on geometry, spatial reasoning, logic puzzles, and so on (see [mathforlove.com](http://mathforlove.com) for some examples).
- Consider offering courses or additional emphasis in statistics, financial math, and discrete math at your school.
- Consider reordering your curriculum to expose students to geometry, probability, and statistics earlier in the year.

- Listen to podcasts that discuss a broader view of mathematics education, including *Make Math Moments That Matter* (Pearce & Orr, 2018–present), *Kids Math Talk* (Harrison, 2020–present), *Sum of It All* (Mendivil & Alcorn, 2021–present), and *DebateMath* (Luzniak & Baier, 2022).
- Check out and create your own events like Math On-a-Stick (<https://talkingmathwithkids.com/mathonastick>) or participate in Global Math Week from the Global Math Project ([globalmathproject.org](http://globalmathproject.org)).
- Advocate for local- and national-level changes to the curriculum by getting involved in various political and educational organizations, such as your state affiliate of the National Council of Teachers of Mathematics (NCTM) or NCSM, Leadership in Mathematics Education.

## Questions for Reflection

### For Teachers

- How might you utilize problems and content from a wide range of areas in your classes?
- Can you reconsider how you organize the topics you teach to move up content that goes beyond algebra and number sense?
- How can you engage students in the study of discrete math, financial math, and statistics?
- What opportunities do your students have to see mathematics as more than numbers and equations?
- How can you bring popular texts in mathematics to your teaching?

### For Instructional Leaders

- How can you work with teachers to help them balance algebra and number sense with other branches of mathematics?
- How can you work with teachers around leveraging real-world topics with statistics and election theory?
- What resources can you provide that challenge traditional views of mathematics?

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**For Administrators**

- How can you support teachers who want to bring in areas of mathematics that are outside algebra and number sense?
- How might you create and/or strengthen courses, activities, events, and opportunities around financial mathematics, discrete mathematics, and statistics?
- In what ways can you ensure that the educational resources and curriculum adopted by your school reflect the diversity of the field of mathematics?
- What mathematical content is reflected in the professional development opportunities offered to the teachers at your school?