Numeracy
Advancing Education in Quantitative Literacy

Volume 5 | Issue 2 Article 7

2012

Review of *Math for Life* by Jeffrey Bennett

Eric Gaze
Bowdoin College, egaze@bowdoin.edu

Recommended Citation

Gaze, Eric (2012) "Review of *Math for Life* by Jeffrey Bennett," *Numeracy*: Vol. 5 : Iss. 2 , Article 7.
DOI: http://dx.doi.org/10.5038/1936-4660.5.2.7
Available at: http://scholarcommons.usf.edu/numeracy/vol5/iss2/art7

Review of *Math for Life* by Jeffrey Bennett

Abstract
Bennett, Jeffrey. 2012. *Math for Life: Crucial Ideas You Didn't Learn in School*. Greenwood Village, CO: Roberts and Company Publishers. 216 pp. Cloth $25. ISBN: 978-1-936221-1.

Math for Life: Crucial Ideas You Didn't Learn in School by Jeffrey Bennett is a general interest mathematics book focused on the topic of innumeracy, the mathematics required to be numerate and why quantitative literacy is important for an educated citizenry. This book raises the very important question of why the mathematics we need to navigate our daily world is given such short shrift in our K-12 math education system. *Math for Life* is directed at multiple constituencies. For those wishing to develop their quantitative literacy, it provides a primer of the crucial topics, explained with compelling examples in an accessible easy-to-read style. For educators, it provides a valuable synopsis of what the math education curriculum should have at its core. I conclude the review with an analysis of the book's contributions to these varied domains. In particular, I call into question the algebra-centric high school curriculum and explore possible alternatives to the current myopic focus on calculus in our broken mathematics education system.

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Keywords
Quantitative Reasoning, Algebra

Cover Page Footnote
Eric Gaze, a mathematician, is the Director of the Quantitative Reasoning Program at Bowdoin College and Vice President of the National Numeracy Network.

Introduction

Math for Life: Crucial Ideas You Didn't Learn in School by Jeffrey Bennett is a general interest mathematics book focused on the topic of innumeracy, the mathematics required to be numerate and why quantitative literacy is important for an educated citizenry. Jeffrey Bennett is one of the co-authors of the popular Quantitative Reasoning (QR) textbook: *Using and Understanding Mathematics*; and many of the key QR concepts from that textbook have been distilled into the lessons and examples found in *Math for Life*. Bennett has three main goals in this new text:

1. Providing a numeracy "primer" which covers the fundamental numeracy concepts required for decision making in the quantitative realms of personal health, finance, and citizenship.
2. Drawing attention to the quantitative nature of many important societal issues such as the national budget, energy consumption, climate change, and political polarization.
3. Offering commentary on the current state of mathematics education in the United States and possible directions for moving to improve this system.

Math for Life does an excellent job addressing these challenges and is a welcome addition to the growing body of QR literature.

Content

Bennett begins the book with several chapters covering the mathematics you need for life, how to think with numbers and think with data. He emphasizes the distinction between computation, which is what we are taught in school, and the much more subtle but critical reasoning skills required to be numerate, i.e., to communicate with numbers and data. Proportional reasoning takes center stage, needed for making sense of the numbers we encounter by making appropriate comparisons via ratios. Percentages and relative change for dealing with quantifying change, unit analysis and uncertainty involved with measurement round out the basics we need for dealing with numbers. Statistical thinking is covered next, and Bennett offers a nice variation on "lies, damned lies and statistics," instead encouraging us to use the refrain "truth, truthiness, and statistics." This recognizes that the truth may be out there, but it is often ignored in favor of decision making based on intuition or personal belief rather than facts (truthiness). Statistics is an attempt to capture the truth in as scientific a fashion as possible given the shades of gray that obscure reality in a world filled with confounding factors and nuance. The fundamentals of sampling and experimental design are followed with an overview of descriptive statistics, the normal distribution, correlation and causation. Bennett is careful to present these ideas in the context of compelling examples, reminding us that "students can't know what they haven't been taught."

The remainder of the book is organized by chapters dedicated to topics every informed citizen needs to know about, all of which build on the foundational numeracy material presented earlier. The first three of these chapters are financial in nature, covering managing your money, taxes, and the U.S. budget/deficit. Each chapter covers the relevant terminology in an accessible manner: liquidity, PE ratios, amortized loans, refinancing, regressive taxes, deductions, value added tax, public debt, discretionary spending, and trust funds are all dealt with in an engaging prose and easy to read style. The text is sprinkled with fun facts that constantly surprise, like the fact that tax breaks such as mortgage interest deductions and not being taxed on employer health benefits (deductions that are far more valuable to the wealthy) add up to over $1 trillion a year!

The next chapter on energy math contains Bennett's provocative calculation of the true cost of energy factoring in health costs due to pollution and the military costs connected to securing and protecting energy supplies. He makes an interesting argument that factoring in these costs would give people a more accurate read on energy usage and a motivation to consider alternatives (which he outlines in detail). The science of climate change is also explored in this chapter. Bennett attempts to remain objective in his presentation of the scientific facts underlying climate science, and is careful to emphasize that predictions are based on models that can have considerable variability. The overall tone is cautionary, with the conclusion reached that the implications of these topics are potentially too dire for us to ignore, similar to his discussion of the social security trust fund in the preceding chapter. Thus he argues for an educational system that addresses these issues early and often.

I enjoyed the chapter on political polarization very much. The fact that the average margin of victory in the 2008 and 2010 congressional elections was more than 30 percentage points, when the presidential elections have shown the country split essentially 50-50, is eye-opening. Bennett starts every chapter with a quotation, and in this chapter he cites President Obama stating "most voters no longer choose their representatives; instead, representatives choose their voters." The ensuing discussion of redistricting and gerrymandering certainly seems like required reading for every citizen of this country.

Bennett ends with a chapter on suggestions for change in the mathematics education system. His observations that:

1. Great teachers are needed for great teaching.
2. You can only learn by studying.

are so obvious that you might think they don't need saying, but I am sure they will be welcomed with cheer by educators everywhere. Regarding mathematics, Bennett notes that the current system of teaching abstract concepts first in the form of algebra over contextual applications flies in the face of educational theory going back to the Greeks. He calls for a more intentional mathematics education with a focus on QR, and offers concrete suggestions at all levels.

Analysis

Math for Life: Crucial Ideas You Didn't Learn in School by Jeffrey Bennett raises the very important question of why the current mathematics curriculum is so devoid of the material needed to navigate our personal worlds of finance, business, and citizenship. Those involved with the National Numeracy Network and the QR movement are undoubtedly familiar with rationale for the "GATC" sequence (Geometry, Algebra, Trigonometry, Calculus). It is billed as a pipeline to the STEM fields (Science, Technology, Engineering, and Mathematics) and the critical professions that drive job growth and scientific/technological innovation. Conventional wisdom dictates calculus in particular holds pre-eminent status as the gateway to STEM. Fifty years ago if you asked STEM faculty in universities and colleges for the mathematical pre-requisites to success in calculus, they undoubtedly would reply algebra, with a bit more algebra, some trig, and then more algebra. Not only does the GATC sequence completely abandon the fundamental middle school math topics necessary for quantitative literacy but all of this algebra taught in the abstract fosters math phobia and supports the culturally acceptable stance that math is not relevant.

The unquestioned importance of algebra is close to gospel in the mathematics education community. U. S. Secretary of Education Arne Duncan's speech April 15, 2011, to the National Council of Teachers of Mathematics (NCTM) contains the line: "Algebra is the key to success in college."[1] This is in stark contrast to the NCTM President Michael Shaughnessy's message in February 2011 titled: "Endless Algebra – The Deadly Pathway from High School Mathematics to the College Mathematics"[2] This is a good example of two well-meaning advocates arriving at radically opposed positions while looking at the same data: Of the 4,012,770 cohort of 2001 9th graders, only 1,303,050 were college ready in fall 2005 and only 166,530 were expected to graduate with a STEM degree this past May 2011. The paltry 166,530 STEM degrees (4% of the entering 9th grade cohort) lead Secretary Duncan to conclude we are experiencing a *STEM crisis* and need to increase the numbers of STEM graduates through "increasing the rigor of what is taught in the classroom" (i.e. algebra). Mike Shaugnessy, on the other hand, looks at the other 3,846,240 students (96%) for whom the "tunnel of repetitive algebra" paid no dividends and sees a *QR crisis* and asks for a better mathematical experience for these students. Secretary Duncan's claim that "Most factory workers need to understand Algebra II or even some trigonometry to operate complex manufacturing electronic equipment" seems hard to believe for those of us who have taught factoring trinomials and solving radical equations to uninterested classes.

How do we reconcile these two positions? At first glance this seems to be another manifestation of the "math wars" between skills drills and constructivist instruction, and that if we seek to address the QR crisis, we only worsen the STEM crisis. I would argue that this is not the case, and that the QR community is not seeking to eradicate algebra, but rather to improve the way it is taught. First, let's look at Secretary Duncan's rationale for declaring algebra the key to success in college. He cites the statistic that students completing Algebra II in high school are twice as likely to graduate from college. Unfortunately the logic here is plagued by the same confounding variable as the argument that AP courses are the key to success in college—namely that more-able students are more likely to complete Algebra II and/or AP coursework, and thus more likely to be successful in college. The College Board has been very successful in using this flawed argument to garner millions of dollars of federal funding for more AP coursework, cramming students into AP courses, and paying for their tests regardless of the outcome.

The similar argument with regard to algebra—cram as much algebra as possible into them and if at first you don't succeed…remediate—is finally being questioned. Most notably, the Carnegie Foundation for the Advancement of Teaching is leading an initiative to create alternative pathways (Statway and Quantway) to the traditional algebra developmental math track at community colleges. They justify this with the statistics that roughly 60% of the 6-million community college students each year enter the algebra-centric developmental math track and approximately 2/3 of them (2.5 million) never finish. Algebra has become a wasteland of de-contextualized symbol manipulation and formulaic memorization, a wasteland where the dreams of higher education and a better life wither and die. The QR community appreciates the severity of the STEM crisis and does not see addressing the QR crisis (creating quantitatively literate citizens) as being at odds with creating more scientists and engineers. In some sense, they are two sides of the same coin. The QR community seeks to create a curriculum that addresses the quantitative reasoning needs of all students, providing meaningful engagement in mathematics that will simultaneously develop quantitative literacy and spark an interest in STEM fields.

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[1] http://www.ed.gov/news/speeches/math-teachers-nation-builders-21st-century (accessed 11 June 2012)
[2] http://www.nctm.org/about/content.aspx?id=28195 (accessed 11 June 2012)

Secretary Duncan states that "One of the best gifts math teachers can give their students is to teach them how to solve complex algebraic equations." Why? He cites one of the most common rationalizations of the current algebra curriculum: that in learning abstract symbol manipulation students are laying the foundation for more general problem solving and reasoning skills. I would counter that the best gift ANY teacher can give a student is to teach them how to think. Period. To argue that factoring trinomials and solving for *x* in the abstract will lead to problem solving in the concrete seems tenuous at best. It is time to put algebra back in its rightful place. Yes the mathematics curriculum needs to build skills but not at the complete expense of any contextual understanding. A balanced approach is needed. Context needs to provide scaffolding for learning, and context should drive the teaching of mathematics. Currently the mathematical content drives the context. NCTM President Mike Shaughnessy points out that the current "layer cake of algebra-dominated mathematics" exists solely to prepare students for calculus, and he offers four concrete alternative pathways:

1. Data analysis, combinatorics, probability and numerical trends/modeling.
2. Statistical thinking and decision making.
3. Linear algebra.
4. Multivariate applications of calculus and statistics.

I would add a fifth strand to be interwoven in all focusing on quantitative reasoning, building and developing the critical middle school mathematics topics that currently are abandoned in high school but serve as the foundation for numeracy. In addition these pathways all would necessarily require algebra to be embedded in the context of the material.

Concluding Comment

Jeffrey Bennett's book, *Math for Life: Crucial Ideas You Didn't Learn in School*, offers the following advice for solving the math education dilemma:

1. Recruit and retain outstanding teachers.
2. Inspire students to study harder.
3. Provide a solid foundation of math skills by incorporating mathematics in all subject areas.

I was struck by the similarity of these three points with Thomas Friedman's suggestions for education reform in his book, *The World is Flat*. He says the most important educational outcome for students in today's rapidly changing knowledge economy is to "learn how to learn." He stresses that curiosity and passion trump raw intellect, and that we need to develop right brain thinking seeking synthesis across disciplines. To accomplish this we need great teachers, because great teachers inspire us. In order for teachers to light this fire ("Education is not the filling of a pail but the lighting of a fire." –Yeats) they also must possess curiosity and passion for learning. Thus it is not just students who would benefit from a context-rich meaningful mathematics curriculum, but also the teachers, forming a powerful feedback loop throughout the curriculum.

I highly recommend *Math for Life*, and think it does warrant a spot on every student/teacher's desk. The ending quotation by H. G. Wells articulates the stakes involved in addressing the challenges Bennett takes on in this book: "Human history becomes more and more a race between education and catastrophe."