Democracy and the Numerate Citizen: Quantitative Literacy in Historical Perspective

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"Political Arithmetick is an art daily growing more important in the United States," wrote the Massachusetts statesman Josiah Quincy in 1816. In a lengthy analysis of an innovative new book on American statistics published in the *North American Review*, Quincy expounded on the connections he saw between statistical knowledge and the duties of citizens and lawmakers in the fledgling American republic. Democratic government, as ordained by the Federal Constitution, made "a knowledge of our civil condition . . . something more than the gratification of mere curiosity." The careful accumulation of hard data about society—"authentic facts," "certain knowledge," "statisticks," in the language of Quincy's day—was essential information for a government whose goal was to promote the general welfare of its citizens. Hard data, Quincy declared,

> "are to be sought, and ought to be studied by all who aspire to regulate, or improve the state of the nation; and even by all who would judge rightly of their duties as citizens, and who are conscientiously scrupulous, even in private life, of so casting their influence into the scale of parties, as best to promote the general happiness and prosperity."[1]

Quincy's language sounds formal, antiquated, musty even, to modern ears, but his point about the growing importance of numbers to an informed citizenry was certainly farsighted. Over the two centuries that America has developed and matured under democratic institutions, numbers and quantities have achieved an overwhelming preeminence in the politics of public life. This is so because "Political Arithmetick" connects to democratic government in three distinct ways. First, the very political legitimacy of a representative democracy rests on repeated acts of counting: tallying people in periodic census enumerations to apportion the size and balance of legislative bodies, and tallying votes in varieties of elections to determine office-holding and public policies. Second, as Quincy suggested, a government whose goal is the general welfare of its citizens needs good aggregate information about those citizens on which to erect and assess public policy. It is no coincidence, then, that the word "statisticks" was coined in English in the 1790s (although what was meant by it was somewhat different from its meaning today). And third, the citizens of democratic governments also need good information, to assess their leaders' political decisions and judge them on election day. Voters certainly have always appraised the character and leadership qualities of candidates, but 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."[2]

To say that there is a vital link between numbers and representative democracy is not to suggest that this was fully understood from the founding days of the United States. The vast majority of citizens

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in 1789 had quite limited numeracy skills, skills that got exercised the most (if at all) in the world of commerce and trade, not in the world of politics. Although at the outset, the U.S. Constitution provided for a decennial census for apportioning the House of Representatives, the Congress took two decades just to begin to realize that the labor-intensive enumeration process could be augmented almost without cost to capture additional data that might be useful for a government to have. Even the apportionment function was carried out with considerable imprecision, showing us that a general faith in representative institutions in 1789 did not yet translate to anything so arithmetically concrete as one man, one vote.

We have moved, over two centuries, from a country where numeracy skills were in short supply and low demand, to one in which the demand is now very high indeed—and in which the supply, while greatly augmented, has not kept up with the need. This Forum is primarily focused on the present and the future, asking how much quantitative literacy is necessary to function in these beginning years of the twenty-first century. But it helps to look backward as well, to understand the development of the ideas linking quantitative literacy to citizenship in a representative democracy. By mapping out the spread of numeracy in specific arenas, we can begin to see what factors spurred the growth of quantitative literacy in American history. More than just arithmetic, the shopkeeper's skill, was highly valued in the early years of our democracy; leaders also championed the study of geometry as a pathway to the superior reasoning skills required by representative government. Our exploration of the practices of arithmetic and geometry instruction will quickly lead us to another important problem: the differential distribution of mathematical skills in past populations, which provides a further important clue to the question of how quantitative literacy bears on citizenship. And finally, we need to move beyond the naïve enthusiasm for "political arithmetick" characteristic of the early nineteenth century, which valued numbers for their seemingly objective, neutral, and therefore authoritative status, to see the symbolic and constructed uses of political numbers that can both convey and hide important information. As we all learned so dramatically in the election of 2000, "simple counting" in politics is never really simple.

This essay looks at three historical eras: the founding generation, from the 1780s to about 1810; the antebellum period, from the 1820s to the 1850s, when direct democracy came into full bloom and the country underwent a market revolution; and the late nineteenth century, when empirical social science became wedded to government and when new citizens—the newly freed slaves and the many thousands of immigrants—posed new challenges and choices for the developing education system. For each period I will sketch out features of the spreading domain of number in service to the state and then assess the levels of numeracy prevalent that helped (or hindered) citizens from functioning effectively as citizens.

The Founding Generation: Who Counts

The writers of the U.S. Constitution embedded three ideas in their ingenious plan of government that implied and eventually fostered a relationship between quantification and politics. First, they chose to erect a representative government that acted on and represented people, not the states, as had the predecessor plan, the Articles of Confederation. The size of each state's population determined the composition of the House of Representatives and the number of electors in the electoral college that selected the president. Second, the Constitution inaugurated a regular and recurring census based on "actual enumeration," and the results would determine not only apportionment in the House and electoral college but also apportionment of direct taxes. And third, the framers handled the thorny problem of noncitizen inhabitants by counting slaves (circumspectly described as "other Persons" in contrast to the category of the "free") at a three-fifths ratio, which meant that slaves added weight, but not full weight, to the political power as well as the tax burden of slave states. (This was judged at the time to be a brilliant compromise between the North and the South; however, with relatively few instances of direct federal taxation before the Civil War—in 1798 and three times in the 1810s—the slave states derived constant political benefit without the counterbalancing pain of taxation essential to the three-fifths clause.)

These features of the Constitution suggest a numerical approach to governance, a way of imagining citizens as individuals who "count" or matter, as objects of, participants in, and paying supporters of government. But in the first several decades, scant attention was paid to direct democracy. (After all, these were the men who gave us the electoral college as a method of selecting the president.) The 1790 census no doubt substantially undercounted the population—Thomas Jefferson and George Washington both suspected that—but its precise accuracy was not a matter of great consternation at the time. Indeed, many of the people tallied in that census—women, children, servants, slaves, the unpropertied—although included for the headcount were never imagined therefore to be active participants in government. The narrow goal of the count was to yield proportional representation at a ratio of one representative to no fewer than 30,000 people, voters or not. The simplicity of the Constitution's mandate, however, was belied by the complexities of actually making a fair apportionment once the population was ascertained. Congress spent over five months on the problem, finding it both a politically and mathematically fraught question. What number of representatives, coupled with what divisor (in the ratio of representation), yielded the closest thing to proportional representation? And crucially, how would remainders be handled? Delaware, for example, had an enumerated population of 50,209 free people and 8,887 slaves, leaving it with one representative and a very large remainder no matter whether a divisor of 30,000 or 33,000 (the number finally chosen) was used. The final two opposing apportionment formulas were the work of Jefferson and Alexander Hamilton, which tells us right there that considerable political clout was at stake. But for much of the winter and early spring of 1792, members of Congress struggled with tedious repetitions of long division, testing out different divisors and trying to fathom the political consequences of different ways of treating the remainders. Little of this internal jockeying made the newspapers, which suggests that the "political arithmetick" of direct democracy was in its infancy then. Probably few citizens of Delaware ever drew the conclusion that their state had been shortchanged.[3]

Further, only a very few political thinkers saw that the innovation of a repeated census might be put to extended uses. Censuses before 1790, both in Europe and in the colonies, had been infrequent acts of monarchical power designed to assess military strength or taxation potential. Not surprisingly, then, enumerations historically had been met with suspicion and sometimes resistance. But in the U.S. case, counting people was a tactic to ensure representation, a good thing. Congressman James Madison served on the committee charged with drawing up the first "enumeration bill" in 1790. Madison proposed an expanded census, one that went beyond a basic tally of free and slave to further categorize people by race, by sex, and—for white males only—by age (those over 16, those under, a split that gauged military manpower). He also proposed that each employed person be tallied as doing either agricultural, commercial, or manufacturing work, arguing reasonably that "in order to accommodate our laws to the real situation of our constituents, we ought to be acquainted with that situation." In the end, however, Congress accepted the race, sex, and age additions but rejected the occupational categorization. As one representative said, it would "occasion an alarm" among the people, for "they would suppose the government intended something, by putting the union to this additional expence, beside gratifying an idle curiosity."[4]

When the 1800 census came up for drafting, two learned societies each petitioned Congress to enlarge the census to serve the cause of science. The Connecticut Academy of Arts and Sciences, located in New Haven, and the American Philosophical Society, in Philadelphia, each memorialized Congress with a plea to turn the census into a national gathering of "authentic facts." Such facts might include the age, nativity, occupation, and marital status of each person so that, over a run of years, future generations could chart the aggregate progress, health, and longevity of the citizens. But again Congress ignored these requests, not thinking them worth the bother.[5] The census was expanded a bit, in that the white population was now recorded in five age classifications for both sexes. The black population, however, whether free or slave, was not distinguished by any sex or age classification. Disparities like this one are very revealing, because they remind us pointedly of the constructedness of political numbers. Who gets counted and how: these are always political decisions. In all the U.S. censuses up to and including the 1840 count, blacks and whites were categorized under different age classifications, making it very difficult to compare their longevity or other vital rates.

The Connecticut Academy of Arts and Sciences undertook to do for Connecticut what it had failed to accomplish at the national level. It embarked on an ambitious survey of all Connecticut towns, with an instrument of 32 questions that probed for an account of the population, the numbers of houses and carriages, local manufactures, the number of clergymen and their salaries, and "instances of suicide in the last twenty years," among other things. The academy leaders failed in that task, too, finding that local respondents were mostly disinclined to collect the data; in the end, only two town studies were published.

The idea for a state-based survey came from a parallel survey project undertaken in Scotland by Sir John Sinclair, the man who came up with the word "statisticks" and defined it to mean "an inquiry into the state of a country, for the purpose of ascertaining the quantum of happiness enjoyed by its inhabitants, and the means of its future improvement."[6] "Statistick" first appeared in an American dictionary in 1803 with an enigmatic definition referring to Sinclair and his "statement of the trade, population, production [of Scotland] . . . with the food, diseases, and longevity of its inhabitants." By 1806, the word gained a clearer articulation in Noah Webster's first dictionary as "a statement or view of the civil condition of a people."[7] The word *state* was embedded in the term in two ways: facts about the state that could be plainly stated. Although such facts might take the form of numbers, this did not become an essential part of the definition for several more decades. By the mid 1820s, just over a dozen books had been published with the word "statistics" or "statistical" in the title, and another 17 not emblazoned with the word still had the character of reference books of authentic facts and numbers. Nearly all these books proclaimed the novelty of their shared project, assembling facts and figures for the aid of statesmen and citizens.[8]

The Founding Generation: Small Steps Toward Greater Numeracy

This slow but definite start to America's affinity for quantification in politics was paralleled by a similarly gradual embrace of arithmetic education in these early years.[9] The founding fathers in the 1790s were quick to form grand schemes to improve education; an educated citizenry was well understood to be the bulwark of a republican government, and there was no shortage of public-spirited plans formulated to improve the mental reasoning of the nation's youngest citizens and future voters. There also were good reasons in particular to address what had been an abysmal state of arithmetic instruction in the colonies. But, as ever, the fulfillment of these good intentions proved considerably harder to accomplish, in view of the costs to taxpayers of public education.

Arithmetic instruction in prerevolutionary America occupied a very narrow slice of what was already not a very generous provision of education before the 1790s. The South's few private schools and tutors educated only a small fraction of the gentry's children. It was in New England where literacy and numeracy were the most advanced, thanks to a patchwork tradition of district schools supported by local and state funds. But even there, significant obstacles kept arithmetic skills at bay, obstacles also at work in the South. The subject was identified with commerce, and generally only boys headed for the mercantile life troubled to learn it. It was demonstrably a difficult and arcane subject, requiring the writing and reasoning skills characteristic of children over age 11 or 12, so anyone whose education did not extend to the adolescent years skipped it entirely—thus, most girls missed out. Simple counting and adding in Arabic numerals below a hundred probably was routinely passed on from parents to children, eminently useful for handling small sums of money, paying taxes, toting up firkins of butter, selling excess eggs, measuring lumber and, in general, thinking about prices in the typically static colonial economy. But anything in the "higher branches" was not commonly taught, except to boys in vocational training.

A glance at any of the arithmetic textbooks used in the colonies reveals how truly convoluted and challenging this subject was. For two centuries, imported English texts had organized knowledge of the arithmetic arts into a catechism-like set of rules that relied on memory rather than reasoning. (The rules in different texts were not so regularized, however, that they found similar expression. Books even jumbled the order of presentation, bragging that no section depended on any previous section for completion.) Generally, a student first was introduced to Arabic numerals and then to the first four rules of addition, subtraction, multiplication, and division in whole numbers. Next, a text might repeat the rules in fractions, or repeat them afresh using denominate numbers—"named" numbers that expressed the elaborate and complex denominations of the English system of weights, measures, and money. Denominate arithmetic was undoubtedly the worst stumbling block in the acquisition of numeracy. Texts presented page after page of equivalencies in gallons and pints, bushels and pecks, pounds and ounces. Often the denominations of volume or size were specific to the item being measured: so, for example, a firkin of butter weighed 56 pounds whereas a firkin of soap weighed 64; a hogshead of beer contained 45 gallons whereas a hogshead of wine contained 63. Troy and apothecary ounces totaled 12 to the pound, whereas avoirdupois ounces equaled 16 per pound. Students struggled with a rule called "reduction," learning to figure how many minutes in a week, how many ounces in a hundredweight, how many inches in 3 furlongs and 58 yards. Reduction was essential for the key problem of calculating the price of measured commodities in pounds, shillings, and pence.

The capstone of basic arithmetic arrived with the "rule of three": "Given three parts, to find the fourth" was the usual phraseology. This rule and its variations (single and double, direct and inverse) covered the basic commercial problem of proportional relationships. If a man pays 1s. 7d. to pasture a cow for one week, how much will it cost him to pasture 37 cows for two weeks? If nine men can build a house in five months, working 14 hours a day, in what time can nine men do it if they work only 10 hours per day? The solution required writing down the three known quantities in a certain order, multiplying the middle term by the last, and dividing the product by the first. Knowing the proper order and choosing the proper version of the rule were essential. Some books helpfully provided gimmicks to aid memory: "If more require more, or less require less, the question belongs to the Rule of Three Direct. But if more require less, or less require more, it belongs to the Rule of Three Inverse."[10]

Arithmetic was unrelentingly mercantile, and the chief method of instruction, up to about 1820, was the copybook. A teacher likely had just one text, and every student copied each rule into a manuscript copybook and worked a selected example for each rule. A student who passed through the major "rules" produced his own permanent record of the rules, essential for later reference in life. A large collection of arithmetic copybooks owned by Harvard University shows that the typical copybook ended with the rule of three. But printed textbooks and a few copybooks forged on, to the rules of fellowship, interest, compound interest, discount, tare and tret, and dozens more that covered seemingly unique business applications.

These textbooks and their derivative copybooks look quite impossible as teaching aids to us now. They eschew explanation, give minimal examples, invoke no repeat drills, and treat each type of problem as a universe unto itself, with nary a hint of logical connections between, say, subtraction and division, addition and multiplication, or fractions and decimals. The rule of three was about the only rule that attempted a form of generalization in abstract numbers and, as the copybooks show, many students were at sea in applying it to novel situations with the burdensome denominate numbers. Yet it is possible that having a multitude of seemingly distinct formulas actually improved marketplace calculation, precisely because a young merchant getting his footing in the world of trade did not try to reason things out but instead paged through his copybook looking for the exact rule that fit the situation. This was applied mathematics, and the point precisely was to give each application its own algorithm. In time, the young merchant would grow very familiar with the particular and limited kinds of calculations his type of business required, and the copybook would have served its purpose.[11] But such a form of training did little to enhance the generalized facility with numbers that we now call quantitative literacy.

This eighteenth-century picture of arithmetic training began to change in the 1790s, coincident with and explicitly connected to the arrival of republican institutions. Citizenship was a term newly invested with patriotic meanings, and leading statesmen contemplated the best pathways for creating an informed citizenry. Raising literacy rates was one obvious strategy, to improve the flow and reception of ideas and information; and reforming mathematics instruction to sharpen citizens' minds was another. No less a public figure than George Washington endorsed mathematics education as a civic benefit: "The science of figures, to a certain degree, is not only indispensably requisite in every walk of civilized life, but the investigation of mathematical truths accustoms the mind to method and correctness in reasoning, and is an employm. peculiarly worthy of rational beings."[12] Thomas Jefferson was on record with his support as well: "The faculties of the mind, like the members of the body, are strengthened and improved by exercise. Mathematical reasoning and deductions are, therefore, a fine preparation for investigating the abstruse speculations of the law."[13]

Jefferson sketched out an ambitious system of education for Virginia that would have provided three years of publicly supported schooling for all free boys and girls, covering reading, writing, and "common arithmetic" (probably to the rule of three). From there, the worthy boys (ones who could pay tuition plus a tiny fraction invited on scholarships) could progress to a Latin grammar school where "the higher branches of numerical arithmetic" would be taught. At the pinnacle, a college would educate the most deserving; here was where algebra and geometry would be encountered.[14] Notable in this plan was the provision for girls to be taught basic arithmetic. But the two lower levels of Jefferson's system were not built in his lifetime. Similar schemes for common school systems in other states were equally hard to implement because of the expense of public education. This meant that colleges—the handful that there were around 1800—generally needed to offer first-year courses in basic arithmetic to compensate for persistent deficiencies at the lower levels of instruction.[15]

Jefferson took another route, however, that had a much more immediate impact on numeracy in the 1790s. As secretary of state under Washington, he proposed a major reform in the monetary system of the nation in 1793, abolishing pounds and shillings in favor of decimal dollars, dimes, and cents. (Jefferson was equally inspired by French Enlightenment plans for the metric system, but that did not fly in the 1790s.) Ease of calculation was Jefferson's goal: "The facility which this would introduce into the vulgar arithmetic would, unquestionably, be soon and sensibly felt by the whole mass of people, who would thereby be enabled to compute for themselves whatever they should have occasion to buy, to sell, or measure, which the present complicated and difficult ratios place beyond their computation for the most part."[16]

By 1796, the mint was producing the new money, triggering the publication of dozens of new arithmetic textbooks with nationalistic titles, for example, *The Federal Calculator*, *The Scholar's Arithmetic: or, Federal Accountant*, *The Columbian Arithmetician*, and *The American Arithmetic: Adapted to the Currency of the United States*.[17] One book of 1796 spelled out explicitly the interconnections between common arithmetic, decimal money, and republican government:

> It is expected that before many years, nay, many months, shall elapse, this mode of reckoning [decimal money] will become general throughout the United States. . . . Then let us, I beg of you, Fellow-Citizens, no longer meanly follow the British intricate mode of reckoning. —Let them have their own way—and us, ours.—Their mode is suited to the genius of their government, for it seems to be the policy of tyrants, to keep their accounts in as intricate, and perplexing a method as possible; that the smaller number of their subjects may be able to estimate their enormous impositions and exactions. But Republican money ought to be simple, and adapted to the meanest capacity.[18]

In other words, bad governments prefer complicated money and innumerate citizens who cannot figure out how a tyrant can be fleecing them, while republican governments should make it possible for people of "the meanest capacity" to be able to decode the country's budget and tax policy.

The Antebellum Era: Numeracy Training Accelerates

Simplified decimal money alone did not drive the coming revolution in arithmetic training. Just after 1820, remarkable innovations and teaching techniques altered the look of arithmetic texts and heightened the social valuation put on numeracy. The underlying cause of this major change is not hard to identify: the rapid and unprecedented expansion of commerce in the years after 1815, when the War of 1812 ended. Economic historians call this the takeoff period of early capitalism, a time when more and more citizens eagerly committed themselves to (or found themselves enmeshed in) a market economy characterized by the rise of banking and economies of scale, the vast development of internal transportation, the introduction of water-powered factories, the sale of and speculation in western lands, wage labor, cyclical financial panics, and urbanization. Added to this, the years after 1820 brought a remarkable democratization of American politics, as state after state did away with property requirements, opened the franchise to all white men, and developed a sharply competitive party system that mobilized voters at the state and federal levels. (In the 1840 presidential election, an impressive 80 percent of eligible voters voted.) And, as noted at the opening of this essay, this was the period when a statistical approach to politics began to flourish, linking good government with vital data and measured economic strength. Both economic and political developments were accompanied by the growth of public education, leading to more schools, more teachers, surer state support, and a gradual bureaucratization of schooling with the development of state school systems starting in the 1830s, of which Horace Mann's leadership in Massachusetts is perhaps the best known. Within this new context, arithmetic education was spectacularly reconceived.

The most impressive change in arithmetic instruction came in the 1820s, when an entirely new approach to the field, based on inductive reasoning, challenged the heavy, memory-based books of the eighteenth century. The move started with a young Harvard graduate named Warren Colburn, who published a text of "intellectual arithmetic" for very young children, ages 4 to 8, that omitted all rules. The book instead consisted of pages of problems in addition, subtraction, multiplication, and division, with whole numbers and fractions, and for the first part of the book the numbers were written out as words, avoiding any explanation of Arabic numerals or the place system. In the next few years, Colburn extended his anti-rule method to another arithmetic text and to an algebra book.[19] By the late 1820s and well into the 1830s and 1840s, dozens of other text authors followed the Colburn method. Some two million copies of Colburn's first book were sold in its first 35 years and it was still in print in the 1850s, reportedly selling over 100,000 copies annually.[20]

Two distinct pedagogical techniques characterized this new approach. First, arithmetic began as a mental (or "intellectual") exercise, done in the mind without pencil and paper and without abstract symbols for numbers and operations. The idea here was to train the mind to reason with numbers, not to do problems by rote formula. An important side benefit was that mental arithmetic could be taught to children too young to read or write. Colburn's second and controversial innovation rested on his claim that children could develop their own calculation techniques, recapitulating mathematics through inductive reasoning. Set a student to work on an addition problem, Colburn advised,

> . . . without telling him what to do. He will discover what is to be done, and invent a way to do it. Let him perform several in his own way, and then suggest some method a little different from his, and nearer the common method. If he readily comprehends it, he will be pleased with it, and adopt it. If he does not, his mind is not yet prepared for it, and should be allowed to continue his own way longer and then it should be suggested again.[21]

The rule of three was entirely omitted from all his books. "Those who understand the principles sufficiently to comprehend the nature of the rule of three, can do much better without it than with it, for when it is used, it obscures, rather than illustrates, the subject to which it is applied."[22] Colburn wanted to end children's slavish reliance on rules and rote learning and to teach them to think for themselves. "Most scholars soon acquire such a habit of thinking and reasoning for themselves, that they will not be satisfied with anything, which they do not understand, in any of their studies."[23]

This "new math" of the 1820s did not completely sweep the field of arithmetic instruction, of course. By the mid 1830s and increasing thereafter, a steady stream of criticism challenged the assertion that students could invent arithmetic wholly in their heads. Texts touting arithmetic by the "deductive" method appeared, presenting axioms and definitions to be memorized and applied. By the second half of the nineteenth century, the inductive method was remembered only as a failure. In the 1870s, the Paterson (New Jersey) superintendent of schools reflected that arithmetic was once "taught backward—reason before observation." Instead, fundamentals, number facts, and rote computation now took precedence over mathematical reasoning. "Reasoning upon facts is the work of a maturer mind," he wrote, something reserved for children age 12 and older.[24]

Nonetheless, Colburn's innovations had galvanized the field of arithmetic instruction, provoking scores of new textbook titles each taking one side or the other in this lively educational debate. (Schools and individual teachers usually chose their own textbooks, creating further incentive for new textbook authors to jump into the market.) After the 1820s, the catechism-like books of the eighteenth century, with their multitudes of terse, unintelligible rules each with a single example, were no longer published, having been rendered obsolete by the new books that outdid themselves in their efforts to connect to students. (The old books remained in use for some time, of course, even though they were no longer being republished in new editions.) Whether they called themselves inductive or deductive, mental or written, or analytic or synthetic, in a third axis of the debate, all the new books joined in an effort to promote solid and generalizable mathematical skills. Arithmetic still was valued for its business applications, but it also was valued for its ability to promote powers of reasoning. It was thought of now as a basic part of every school's curriculum, not a set-aside appropriate for future merchants alone.

Although more children were learning basic arithmetic and learning it better than ever before, coverage was uneven, of course, only reaching children who attended school; the days of mandatory school attendance lay far in the future. What is perhaps most striking about this early period of the flowering of numeracy is that it was, in theory, as available to young girls as it was to young boys. This was an unprecedented development. Before 1820, girls had only limited chances to become proficient in arithmetic. The spread of common schooling, the drop in the age at which formal arithmetic instruction began (from 11 to 12 down to 5 to 6), the disconnect between narrow vocational training and arithmetic, and—perhaps most significant—the large-scale entry of women into the teaching profession: all these factors combined to bring arithmetic instruction into the orbit of young women.

It was not an unproblematic development, however. It is ironic that, when at long last basic arithmetic education was routinely available to young girls in school, critics of that development began to assert that girls had a distinctly lesser talent for mathematics than boys. It is a gender stereotype that was actually rather new in the nineteenth century or, if not entirely new, appearing in a new and more precise form. In the eighteenth century, when proficiency with the rules of figuring was the province of boys bound for commercial vocations, any gender differential in mathematical skill could easily be understood as the product of sex differences in education. Women were less numerate than men, and they were also less often literate, but no one needed to conclude that women had an innately inferior capacity for reading the printed page just because fewer women could read. So too with numbers: the divide between the numerate and innumerate was traced to specific training and needs, not to sex-based mental capacity. And, to be sure, many female activities of the eighteenth century required, if not actual arithmetic performed via rules, then some degree of what we now see as part of a mathematical intelligence—counting, spatial relations, measuring, halving and doubling—as women went about cooking, weaving, knitting, and turning flat cloth into three-dimensional clothing without benefit of patterns.[25]

But in the early nineteenth century, when young girls finally had a chance to be included in formal arithmetic instruction, the perceived differences between the sexes were increasingly naturalized. Critics of arithmetic instruction for girls questioned whether girls needed it. "Who is to make the puddings and pies" if girls become scholars, one critic wondered. A state legislature objected to "masculine studies" in mathematics at one school, studies with no discernable bearing on the making of puddings and stockings. "What need is there of learning how far off the sun is, when it is near enough to warm us?" said a third.[26] Of course, there were champions of arithmetic instruction for girls. Most argued that a knowledge of household accounts was highly valuable for thrifty wives to have, but a few moved beyond the purely practical and staked their claim on the mental discipline and reasoning acquired through arithmetic and the higher branches of mathematics.

Geometry in particular became the real battleground in this debate in the 1820s and 1830s. Vaunted by European and American Enlightenment thinkers for its ability to teach citizens to reason, geometry had escaped the deadening pedagogy of rule-based commercial arithmetics. It rested on comprehensible axioms and definitions, mobilized in elegant, logical arguments. A handful of girls' academies took up the challenge of putting Euclid into the hands of students—Emma Willard's famous Seminary at Troy, New York, was one, and Catharine Beecher's school in Hartford, Connecticut, was another. Beecher saw geometry as a mental gymnastic, good for "disciplining and invigorating the powers of the mind."[27] But critics professed to be shocked, as seen in this reaction to the news in 1824 that a Philadelphia girl's school was taking up geometry: "The proper object of geometry is the development of the abstract properties and relations of space. In this science it cannot be expected that females will make much proficiency. Nor ought geometrical knowledge be considered as a necessary object of their pursuit."[28] The real concern for many was the blurring of sex roles and the creation of overly intellectual women that instruction in geometry implied, and the debate remained a lively one up until at least the 1850s. A middle course struck by one contributor to the debate helpfully suggested that no social harm would result if young women studied algebra and geometry, because their innate desire to be pleasing to men would keep them modest about their attainments. Similarly, their mothering instincts would remain unscathed: "Would [a mother] desert an infant for a quadratic equation?"[29] Of course not. But it took more than confidence in women's yearnings to be wives and mothers to quell this debate. In the end, it was the economic advantages of a female (cheap) labor force to fill public teaching positions that helped undermine the prejudices against women learning algebra and geometry.

The Antebellum Enthusiasm for Statistics

As the new arithmetic texts prospered and the higher branches became more familiar to many, so too did the use of numbers and statistics in American civic life. It is a chicken-and-egg question to ask which inspired which. Certainly the two phenomena were mutually reinforcing. A basic numeracy, along with a basic literacy, was fast becoming the hallmark of American public life. And this showed in the repeated uses of numbers and statistics that materialized in the newspapers, periodicals, and public debate of antebellum America.

Let me just itemize, quickly, some of the places in which a numerical frame of mind freshly and creatively took hold. The U.S.

Congress slowly shed its earlier reluctance to maximize the information derived from the census. The 1810 enumeration, launched during the failed embargo policies of Jefferson and Madison in the prelude to the War of 1812, was pressed into service as a way to learn about the actual state of manufactures and industry in the country. For the first time, data were collected that went beyond population, but the actual results were riddled with errors and many omissions. The 1820 census finally noted occupation, but again the effort was rudimentary, sorting all working adults into only three expansive categories. The 1830 census broadened the scope to further fine-tune age categories for the white population (but not the black) and to count the numbers of deaf, dumb, and blind in the population; here we see the start of federal interest in social statistics. But it was in 1840 that Congress completely succumbed to the siren song of statistics. The census population schedule expanded to 74 columns, adding new inquiries about the number of insane and idiot Americans, the number of scholars and schools, a tally of literacy, and a headcount of revolutionary war pensioners, a category associated with direct government expense. A second schedule also filled in by all enumerators contained 214 headings and answered Congress's blanket call for "statistical tables" containing "all such information in relation to mines, agriculture, commerce, manufacturers, and schools, as will exhibit a full view of the pursuits, industry, education, and resources of the country." From this massive aggregation, a person could learn the number of swine, of retail stores, of newspapers, of the bushels of potatoes and 200 more economic "statistics" (i.e., descriptive numbers) for every census district in the United States.

This deluge of statistics was eagerly awaited by the reading public. A variety of statistical almanacs first appeared and gained popularity in the 1830s, and they were eager to carry news of America's progress to their readers. The *American Almanac and Repository of Useful Knowledge* was an annual Boston publication dating from 1830, which was devoted to statistics, defined as "an account of whatever influences the condition of the inhabitants, or the operations of government on the welfare of men in promoting the ends of social being, and the best interest of communities."[30] This almanac filled its pages with miscellaneous figures—on banks, canals and railroads, pupils and schools. Other annual publications had a strictly political focus, such as the *Politician's Register,* begun in 1840, and the *Whig Almanac and United States Register,* begun in 1842; both recorded elections back to 1788 for many localities and provided county-level data for recent elections, giving readers information to strategize future campaigns.[31] We take this kind of data for granted now, but it was newly publicized information in the years around 1840—not coincidentally, the year when electoral participation was at an unprecedented high, a high that was sustained for another five decades.

Another rough but very innovative act of political quantification arrived on the scene in the 1850s, the straw poll of voters. Journalists roamed the public thoroughfares, targeting mixed assemblages of people, often passengers on a steamboat or a passenger railroad, to ask about voter preference in an upcoming election. Interestingly, women passengers usually were not excluded from such polls even though they were not voters, but their votes were tallied separately from men's (which is how we can know that women were asked). These 1850s straw polls were the first American efforts to quantify public opinion.[32]

Antebellum newspapers, the everyday reading of many thousands of Americans, studded their columns with facts and figures. A very typical small item, from the New York *Herald* of 1839, titled "Railway and Stagecoach Travelling," drew on "a return of the mileage and composition duties on railway and stage carriages respectively" to show that over the previous two years, 4,800,000 fewer persons had traveled by stage while 14,400,000 more persons had traveled by railway.[33] No meaning or analysis was attached to these data; they simply stood alone, in manifest testament to the railroad revolution that all the *Herald*'s readers knew was underway. Mileage of railroad tracks was another favorite and frequent boast. But newspaper readers of the 1830s would not have been able to learn the total number of lives lost in steamboat explosions and accidents over that decade (unless they added up the losses reported for each accident, a rather shocking sum that historians have been able to reconstruct).

Not all statistical reports were cheery and boastful. The antebellum era has been tagged the "era of reform" by some historians for the rich variety of civic movements dedicated to eradicating social problems. Although the federal and state governments were not yet counting and publicizing the numbers of inebriates, prostitutes, or runaway slaves, other associations were—the temperance, moral reform, and abolitionist movements. A faith in the unimpeachable truth of numbers was part of the landscape now, and the most powerful way to draw attention to and gain legitimacy for a political or social goal was to measure and analyze it with the aid of arithmetic, giving the analysis the aura of scientific result.

It was in the 1850s that statistics were finally harnessed to opposing sides of the most pressing political division in the history of the United States, the conflict over slavery that led to the Civil War. In this decade-long debate, we can most clearly see the political constructedness of numbers and their mobilization to serve both symbolic and instrumental functions. Although it is very unlikely that anyone—a voter, a member of Congress—changed opinions about the sectional crisis based on quantitative data, it is instructive to see how both sides tried hard to harness the numbers to endorse their own predilections.

The quantitative dueling started in the congressional debate over the 1850 census. This was the first census designed to gather information on the individual level rather than the household, and the initial proposal included revealing individual-level data about slaves. Although relegated to a separate slave schedule, slaves were to be identified by name, age, sex, color, and place of birth. In addition, the proposal included asking for the number of children ever born of each woman, whether alive or dead now, and then a measure of the "degree of removal" from white or black in race. Southern congressmen powerfully objected to this level of data collecting, which would enable significant comparisons of blacks and whites as to fertility, longevity, and family formation. An acrimonious floor fight resulted in the removal of a significant part of the schedule. In the end, slaves were listed by number, not name, and place of birth and number of children were omitted, along with the explosive question on racial admixture. Political maneuvering had blocked the collection of data that would have furthered potentially invidious comparisons between North and South.[34]

Remaining parts of the 1850 census lent themselves to the North-South debate, however. In 1857, an antislavery southerner named Hinton Helper published *The Impending Crisis of the South,* a book that used the agricultural and social statistics of the census to argue that the South was trailing behind the North in every conceivable measure of economic productivity, wealth, education, and general progress. The fault, Helper declared, was slavery. Helper's book created quite a stir, and many northern and southern commentators wrestled with the questions it provoked. If slavery was bad, what about menial wage labor in the North? If the South's economy was ruined, why were there more paupers in New England than in the South? One critic pointed to Helper's mistake of comparing plain numbers from the census without recasting the data to take account of state sizes, a mistake in the "rule of simple proportion" that "any schoolboy can calculate."[35] But since Helper's error had eluded him and most of his supporters and critics, it is doubtful that a typical schoolboy in the United States would have had sufficient quantitative literacy to recognize the problem.

Arithmetic and Statistics in the Late Nineteenth and Twentieth Centuries

The post–Civil War era finally brought a full melding of statistical data with the functioning of representative government. A century after the first census of 1790, no one any longer suggested that an expanded census would alarm the people or merely gratify idle curiosity. The government had accepted an ongoing obligation to monitor the vital signs of the nation's health, wealth, and happiness. The census bureau was at last turned into a permanent federal agency, lodged for a time in the Department of Labor and later the Department of Commerce. The rapid urbanization and industrialization of the country suggested the agenda for national statistics collection, with a new focus on urban problems, immigration, labor conditions, and standards of living. Unlike mid-century censuses, which had been run by men with no particular training in mathematics, the later census officials, such as Carroll Wright and Francis Amasa Walker, came from the new ranks of professionally trained economists and statisticians. Statistics was no longer limited to descriptive number facts; work by European thinkers such as Adolphe Quetelet, Francis Galton, and Karl Pearson had pushed the field into an increasingly sophisticated mathematical methodology. Federal censuses still were used to apportion Congress, but that was a minor sideline to a much larger enterprise engaged in measuring social indicators that would be helpful not only to legislators but to external commercial agencies and businesses as well, including universities, private research organizations, and trade associations.[36]

This growing sophistication of government statistical surveillance was not matched by a corresponding improvement in quantitative literacy on the part of the public. Unlike the early nineteenth century, when a public enthusiasm for numbers and arithmetic developed along with a statistical approach to civic life, in the early twentieth century the producers of statistics quickly outstripped most consumers' abilities to comprehend. The number crunchers developed more complex formulations while the arithmetic curriculum stagnated—this despite two further major attempts to reform the mathematics curriculum, first in the 1910s to 1920s and again in the 1950s to 1960s.

In the earlier phase of reform, a new breed of specialist—the professional mathematics educators in the university—addressed the problem of a rapidly growing student population assumed to have limited abilities. Foreign immigration and African-American migration combined with new compulsory schooling laws shifted the demographics of American schools. The percentage of youth ages 14 to 17 who attended school went from 10 percent in 1890 to 70 percent by 1940; the decades of maximum change were the 1910s and 1920s. When primarily middle- and upper-middle-class students had attended high school or academy, higher mathematics was typically served up in two or three standard courses, algebra, geometry, and trigonometry. But when the children of immigrants, emancipated slaves, and industrial workers arrived on the high school's steps, the wisdom of teaching the higher branches for the intellectual development they promised was increasingly called into question. A leading educational theorist, Edward Thorndike, reversed the truism of the early nineteenth century and argued that mathematics did *not* encourage mental discipline. Vocational education and the manual arts became prominent themes in educational circles, promoting the line that instruction should be geared to likely job placement. Several states removed all mathematics requirements for graduation and, predictably, enrollments declined. One study of Baltimore's schools in the 1920s explicitly recommended that algebra and geometry be withdrawn from the curriculum for worker's children because of their "lack of practical value" and that they be replaced by a two-year course that would teach mathematics "needed as a working tool in industry." In 1905, a Milwaukee trade school for mechanics endorsed mathematics only as a subject taught via practical problems that arose in the context of the specific mechanical tasks at hand.[37] The history of arithmetic education and blacks in the post-emancipation period is one yet to be written, although its outlines can be guessed at in light of the manual arts training promoted by black and white educational leaders. The details of how the most basic numeracy was imparted to a population just on the threshold of literacy will likely be an important story, however, in view of persistent race differentials in mathematics achievement in late twentieth-century America.[38]

In the second period of curricular reform, the 1950s to 1960s, university educators along with mathematics professors joined to revamp the K–12 mathematics curriculum in a climate of Cold War competition with the Soviet Union over scientific brainpower. The result was the widely publicized "new math" program that attempted to introduce set theory and discovery methods into the elementary school curriculum. In the judgment of current researchers, the new math resulted in a lot of sound and fury but made much less of a dent in actual mathematics instruction, in part because teachers were not nearly so enthused about the new or so ready to abandon the old methods of instruction.[39] Further, the new math tended to the abstract and thus had little effect in promoting the kind of quantitative literacy related to political or civic life.

Conclusion

This brief survey of quantitative literacy and citizenship in the nineteenth century has tried to demonstrate that although there is a natural affinity between numerical thinking and democratic institutions, that affinity was not necessarily predicated on quantitative sophistication on the part of citizens, at least not at first. Representative democracy originated in a numerical conception of the social order, under the U.S. Constitution. That same document ordained that government should "promote the general welfare and secure the blessings of liberty," a mandate that around 1820 was increasingly answered with a turn toward "authentic facts" and statistics. Statistics soon became compressed into *quantitative* facts, an efficient and authoritative form of information that everyone assumed would help public-spirited legislators govern more wisely. Schools, both public and private, correspondingly stepped up arithmetic instruction for youth, bringing a greatly simplified subject to all school-attending children and making it possible for them to participate with competency both in the new market economy and in the civic pride that resulted from the early focus on quantitative boasting.

As basic numeracy skills spread, so did the domain of number in civic life. The unsophisticated empiricism of early statistical history yielded to a more complex political terrain where numbers were enlisted in service of political debates and strategizing. At mid-century, the level of quantitative mastery required to keep up with debates based on numbers was still within the reach of anyone schooled in long division and percentage calculations. At a deeper level, the quantitative savvy required to challenge numbers (for bias, for errors in measurement and counting, for incorrect comparison of figures, for selective use of numbers) was not well developed, either in the producers or consumers of numbers. Choices about what to count and what not to count might be made naively, or purposefully and politically, as in the decision not to collect comparable demographic data on blacks and whites in the census.

Since the late nineteenth century, statistics has become a branch of mathematics and a powerful tool of the social sciences, but there has been little corresponding change in the arithmetic curriculum delivered to the vast majority of school-attending children. A much higher percentage of children attend primary and secondary school now compared with the late nineteenth century, which would suggest that the diffusion of civic numeracy also should be higher than a century ago. But at that crucial time of vast demographic change, back around 1890 to 1920, educators too often responded by scaling back or abandoning requirements such as algebra and geometry, setting them to the side with other subjects, such as Latin, now deemed unnecessary and even inappropriate for the children of immigrants and workers. Vocational tracks with courses on bookkeeping proliferated in the 1920s and garnered high enrollments mainly from female students preparing for clerical jobs. Aside from that, however, little thought was given to what might replace the once-standard higher mathematics curriculum of nineteenth-century academies. Noncollege-bound students continued to be sidelined and shortchanged in mathematics preparation so that now, something as basic as reinstating algebra as a high school graduation requirement (as recently happened in California) leads some to predict that graduation rates will tumble. Both sides in the current "math wars" debate acknowledge that the mathematical competencies of U.S. high school students are worrisomely low.[40] And quite apart from the math wars issue, high schools have not taken on the task of developing courses specifically aimed at teaching a kind of practical, context-based "political arithmetic" that would help students learn to evaluate the types of numbers that are routinely invoked in political life.

Our political system today uses and produces numerical data at a rapid clip, and the numbers are often in dispute or contradiction. Both the politicians and the voters may be in over their heads when it comes to evaluating different projections on the future of Social Security, the differential and future effects of tax cuts, the flow of immigration into the country, the rising or falling of student test scores, and the gyrations of the stock market as summarized in a few one-number indexes reported hourly on the radio. The danger is that we may not realize we are in over our heads. The attractiveness of numbers and statistics in the early- and mid-nineteenth century arose from their status as apparently authoritative, unambiguous, objective bits of knowledge that could form a sure foundation for political decisions. That may have been naïve, but gains in numeracy enabled some, at least, to learn to question numbers, to refine them, and to improve on their accuracy. Now, however, numbers are so ubiquitous and often contradictory that some fraction of the public readily dismisses them as "damned lies."[41]

The recent bandying about of the term "fuzzy math" furthers suspicions about numbers; when used in the political context, it seems to condemn arithmetic and "political arithmetic" alike. Wrenched from its origins as a legitimate if esoteric mathematical term dating from the 1960s, fuzzy math was first appropriated and rendered perjorative by the critics of curriculum reform in the mid 1990s, most famously and nationally by then-National Endowment for the Humanities (NEH) chair Lynne Cheney in a 1997 *Wall Street Journal* essay. It was lifted to national attention by George W. Bush in the first presidential debate in the fall of 2000, when Bush used it to characterize Al Gore as a number-benumbed pedant who was, in Bush's charge, eliding the truth with numbers. In its most recent turnabout, the term has been slapped back on Bush by the *New York Times* columnist and economist Paul Krugman, whose book *Fuzzy Math: The Essential Guide to the Bush Tax Plan* excoriates the Bush administration's arithmetic on tax relief.[42]

So what is to be done? Statistics are not the perfect distillation of truth that early nineteenth-century statesmen thought they were, but neither are they the products of fuzzy math that can be safely disregarded or disparaged. Statistical reasoning and the numbers it produces are powerful tools of political and civic functioning, and at our peril we neglect to teach the skills to understand them in our education system. Some of this teaching needs to happen in arithmetic and mathematics classes, but some of it must be taken up by other parts of the curriculum, in any and every place in which critical thinking, skepticism, and careful analysis of assumptions and conclusions come into play.

On my campus (the University of California at Santa Barbara) and no doubt many others, two programs developed in the last decade or two aimed to generalize basic skills. The first, "Writing Across the Curriculum," devised ways to implant intensive writing experiences in courses well beyond the expected domains of the English department or writing program—say, in engineering and the sciences. Additionally, composition teachers taught writing courses keyed to the science and social science curricula. And in a related fashion, language instruction and practice branched out from the confines of courses on vocabulary and grammar to attach themselves to relevant subject matters. A Western Civilization course thus might have one section taught in French or German, with a portion of the readings also in that language. The idea was to demonstrate the utility and importance of language skills (foreign or English) by crossing the parochial disciplinary boundaries that tend to structure academia. In a parallel way, quantitative literacy needs to be generalized across the curriculum, not only at the college level but in all the earlier grades as well.

The subject matter of history can no doubt play an important role in this process. A list of ideas for units or topics in a U.S. History course (see Appendix A) shows a few ways in which quantitative literacy skills can be called on to deepen and enrich our understanding of some classic and central events in our nation's history. At the same time, teaching units like these would enhance students' quantitative skills, helping to answer that age-old question asked in many mathematics courses, "hey, are we really ever going to need this stuff?" Quantitative concepts are indeed embedded in our civic culture, and quantitative literacy on the part of citizens is greatly needed to make democratic institutions work. It is a worthy goal to make those connections explicit in history and government courses, by showing how numbers, both flawed and accurate, have played a role in past debates.

Appendix A: Promoting Quantitative Literacy in U.S. History Courses

The suggestions below illustrate ways in which typical U.S. history survey courses in high school or college can be enhanced with quantitative ideas. These ideas all link to large events that are routinely taken up in such courses, but rarely do instructors linger over them, perhaps because they seem too complex or abstruse. My suggestion is that we should deepen these stories to draw on (and enhance) students' skills in quantitative reasoning. By exploring the quantitative dimension of these situations, students can better understand what the participants in these events thought they were doing and can better evaluate options for policy or action.

1. Teach the writing of the Constitution to emphasize the quantitative implications and underpinnings of democracy. Was it "one man, one vote" at the beginning? Is it now? How does apportionment work? What does it matter what method is chosen? And what would that mean anyway?

2. Teach a detailed unit on the 3/5 clause as a North-South compromise. Trace it out over the next 70 years: How much extra political clout did the South have in Congress because of this clause? (In 1820, at the time of the Missouri Compromise, the South had 17 more representatives than it

would have had if representation had been based only on the free population.)

3. Focus on the electoral college: Why was it set up the way it was? Does it favor the inhabitants of small or large states? Where did the "winner take all" idea enter, and why?

4. Study the rise of popular voting for the presidency. How do we combine a popular election for the presidency with the electoral college?

5. Study tariff policies in the early republic. Why was there a tariff at all? What social, economic, or political objectives were served by tariffs, beyond the raising of revenue for the government? Did tariff makers have adequate information about the country's economic circumstances to make reasoned tariff policy? (Recall Andrew Jackson's politically strategic campaign promise to be in favor of "a judicious tariff.") Focus on the tariff of abominations of 1828, which led directly to the nullification controversy of 1832, a major showdown on federal versus state power.

6. Consider national land policy during the nineteenth century with respect to the selling of the national domain. How should government handle such a valuable resource? How did the government, at various times, set up land sales? What were the origins of the rectilinear survey idea? How were the survey lines run? What were the procedures on size of parcels? Who gained benefits and who did not?

7. How did women gain literacy and numeracy? What was at stake in this development? How did post-emancipation blacks gain literacy and numeracy? What was at stake? Why had it been illegal in most southern states to teach slaves to read? Who stood to gain from promoting numeracy for blacks? Who stood to gain by obstructing it? How did immigrant groups new to America gain fluency in English, literacy, and numeracy? Again, what factors promoted or obstructed the gaining of this knowledge?

8. What has been the average life expectancy over our country's history? How is that number arrived at? How has it changed over time? How does it vary by race, by sex, by region, and why? Who first tried to frame this question and answer it, and why? Why was/is it worth answering?

9. What is the history of poverty in America? How has poverty variously been defined and measured? What was at stake, say, in enumerating paupers in nineteenth-century censuses? Or idiots and the insane?

10. Ditto for the history of wealth. How has wealth been measured? What about income? How have historians talked about or defined economic classes, and why? How legitimate is it for us to impose some quantitative notion of wealth to stratify a past population when perhaps the members of that population did not think about their own community that way at all? (For example, compare the wealth distribution of a Puritan village, based on land records, versus that same town's sense of its own hierarchy as embedded in the church seating chart, in which other factors besides wealth, or in place of wealth, determined a person's social location.)

11. In the late nineteenth century and later, where did quantitative knowledge come from? Who generated it? Who processed it? Who abstracted it? Who defines the standard measures—of weight and quantity, of economic indicators—and what difference might that make?

12. Who invented the measurement of "unemployment" and when? What was that measure based on? This could be done with any number of common indicators we now use. The idea is to get students to understand the historical forces that go into constructing numbers and measures. What were the mechanisms and procedures for data collection? Who collected data, and to what end? What kinds of data were available? Where should we best look for dispassionate, objective data—politicians, the census bureau, university experts, journalists, media conglomerates?

Notes

1. "A Statistical view of the Commerce of the United States of America; its connection with agriculture and manufactures, and an account of the publick debt, revenues, and expenditures of the United States. . . By Timothy Pitkin. . . , *The North American Review and Miscellaneous Journal* 3(9): (1816): 345–54. The published review was unsigned, but the copy digitized on Cornell University's Making of America Web site includes attributions for many articles in this volume, added in an early nineteenth-century cursive hand. "J. Quincy" was written at the head of this piece, on p. 345; "Josiah Quincy" also was on a similar but very long review in the same volume, a review of Moses Greenleaf's *Statistical View of the District of Maine* (pp. 362–426). The federalist Josiah Quincy (1772–1864) had a distinguished career in politics and higher education. He served in the U.S. Congress for Massachusetts from 1805–1814, in the state senate from 1815–1821, as a judge in 1821–1823, as mayor of Boston from 1823–1829, and finally as president of Harvard University from 1829–1845.

2. The phrase "Political Arithmetick" was first used by the English economist Sir William Petty in the late seventeenth century to describe what seemed to others to be an unorthodox combination of high-level statecraft with arithmetic, which was then seen as a "vulgar

art" beneath the notice of leaders because of its associations with the world of commerce. Petty promoted the expression of all political and economic facts in terms of "Number, Weight, and Measure." William Petty, *Political Arithmetick* (London, 1690), reprinted in Charles Henry Hull, ed., *The Economic Writings of Sir William Petty*, 2 vols. (Cambridge, UK: At the University Press, 1899), I: 244.

3. Margo J. Anderson, *The American Census: A Social History* (New Haven, CT: Yale University Press, 1988), 15–16. In the end, remainders were ignored, in accordance with Jefferson's plan; Hamilton's plan had provided for extra seats distributed to the states with the largest remainders.
4. Quoted in Patricia Cline Cohen, *A Calculating People: The Spread of Numeracy in Early America* (New York, NY: Routledge, 1999), 159–60.
5. Cohen, *A Calculating People*, 161–62.
6. John Sinclair, *The Statistical Account of Scotland* (Edinburgh, 1798), vol. 20, xiii.
7. S.v. "statistick," John Walker, *A Critical Pronouncing Dictionary and Expositor of the English Language* (Philadelphia, 1803); "statistics," Noah Webster, *A Compendious Dictionary of the English Language* (New Haven, 1806).
8. A list of 31 of these books appears in Cohen, *A Calculating People*, 254, n.3.
9. See Patricia Cline Cohen, "Numeracy in Nineteenth-Century America," forthcoming in George M. A. Stanic and Jeremy Kilpatrick, eds., *A History of School Mathematics* (Reston, VA: National Council of Teachers of Mathematics, 2003).
10. Nicholas Pike, Pike's *Arithmetick* (Boston, 1809), 101. Small print helpfully elaborated that "more requiring more, is when the third term is greater than the first, and requires the fourth term to be greater than the second."
11. I had not considered this possibility until I read Zalman Usiskin's essay, "Quantitative Literacy for the Next Generation," in *Mathematics and Democracy: The Case for Quantitative Literacy,* Lynn Arthur Steen, ed. (Princeton, NJ: National Council on Education and the Disciplines, 2001), 79–86.
12. George Washington to Nicolas Pike, author of the first American arithmetic text, June 20, 1788, quoted in George Emery Littlefield, *Early Schools and Schoolbooks of New England* (New York, NY: Russell and Russell, 1905), 181.
13. Thomas Jefferson to Co. William Duane, October 1812, quoted in Florian Cajori, *The Teaching and History of Mathematics in the United States* (Washington, D.C.: Bureau of Education Circular, 1890), 35.
14. "Bill for the More General Diffusion of Knowledge," 1779, Virginia State Legislature; and Thomas Jefferson, *Life and Selected Writings*, Adrienne Koch and William Peden, eds. (New York, NY: Modern Library, 1944), 262-63. Plan discussed in Richard D. Brown, *The Strength of a People: The Idea of an Informed Citizenry in America, 1650–1870* (Chapel Hill, NC: University of North Carolina Press, 1996), 75–76.
15. Harvard made common arithmetic a requirement for admission in 1802; on colleges, see Cohen, *A Calculating People*, 123.
16. Thomas Jefferson, "Second State of the Report of Weights and Measures," April–May 1790, in Julian P. Boyd. ed., *The Papers of Thomas Jefferson*, vol. 16 (Princeton, NJ: Princeton University Press, 1961), 631.
17. *The Federal Calculator, or American Schoolmaster's Assistant and Young Man's Companion* (actually just an 1803 version of the older Thomas Dilworth book from England with federal currency added); Daniel Adams's *The Scholar's Arithmetic: or, Federal Accountant* (1801); William B. Allen's *The Columbian Arithmetician; or New System of Theoretical and Practical Arithmetic* (1811); and Oliver Welch's *The American Arithmetic: Adapted to the Currency of the United States* (1813).
18. Erastus Root, *An Introduction to Arithmetic for the Use of Common Schools* (Norwich, CT: 1796), preface.
19. Warren Colburn, *First Lessons, Or, Intellectual Arithmetic on the Plan of Pestalozzi* (Boston, 1821); *Arithmetic Upon the Inductive Method of Instruction* (Boston, 1826) and *An Introduction to Algebra upon the Inductive Method of Instruction* (Boston, 1826).
20. Theodore Edson, "Warren Colburn," *American Journal of Education* 2 (1856), 302.
21. Colburn, *Arithmetic Upon the Inductive Method of Instruction*, 4–5.
22. Colburn, *Arithmetic Upon the Inductive Method of Instruction*, 7.
23. Colburn, "Lecture XI, On the Teaching of Arithmetic," *The Introductory Discourse and Lectures Delivered in Boston Before the Convention of Teachers, Annual Meeting* (Boston: American Institute of Instruction, 1830), 283.
24. E. V. DeGraff, *The School-Room Guide* (Syracuse, NY: C. W. Barden, 1882, 11th ed., first published 1877), 184.
25. See Cohen, *A Calculating People*, 139–49, for a fuller treatment of this gendered development.
26. All quoted in Cohen, *A Calculating People*, 146–147.
27. Catharine Beecher, "First School Closing Address," October 18, 1823, folder 314, Beecher Collection, Schlesinger Library, Harvard University, Cambridge, Mass.
28. *The Portfolio* (Philadelphia) 17 (1824): 456.
29. *Western Academician and Journal of Education and Science* (Cincinnati) I (1837): 438.
30. Joseph E. Worcester, *The American Almanac and Repository of Useful Knowledge*, I (1930), 139.
31. *The Politician's Register* was published in Baltimore by G. H. Hickman; *The Whig Almanac* was the work of Horace Greeley, editor of the New York *Tribune*.

32. Susan Herbst, *Numbered Voices: How Opinion Polling Has Shaped American Politics* (Chicago: University of Chicago Press, 1993), 74–79.
33. New York *Herald*, April 17, 1839.
34. Margo J. Anderson, *The American Census*, 40–41.
35. Margo J. Anderson, *The American Census*, 53–55; Cohen, *A Calculating People*, 222–24. Quote is from Samuel M. Wolfe, *Helper's Impending Crisis Dissected*, quoted in Anderson, 55.
36. The story of the industrial era's censuses is well told in Anderson, *The American Census*, ch. 4.
37. George M. A. Stanic and Jeremy Kilpatrick, "Mathematics Curriculum Reform in the United States: A Historical Perspective," *International Journal of Educational Research* 17 (1992), 409–11; Herbert M. Kliebard, *Schooled to Work: Vocationalism and the American Curriculum, 1876–1946* (New York, NY: Teachers College Press, 1999), 93, 156.
38. No research that I am aware of yet addresses this question for the late nineteenth century. See Danny Bernard Martin, *Mathematics Success and Failure Among African-American Youth: The Roles of Sociohistorical Context, Community Forces, School Influence, and Individual Agency* (Mahwah, NJ: Lawrence Erlbaum Associates, 2000); James D. Anderson, *The Education of Blacks in the South, 1860–1935* (Chapel Hill, NC: University of North Carolina Press, 1988); and Donald Spivey, *Schooling for the New Slavery: Black Industrial Education, 1868-1915* (Westport, CT: Greenwood Press, 1978).
39. James T. Fey and Anna O. Graeber, "From the New Math to the *Agenda for Action*," forthcoming in Stanic and Kilpatrick, eds., *A History of School Mathematics*.
40. Diana Jean Schemo, "Test Shows Students' Gains in Math Falter by Grade 12," *New York Times*, August 3, 2001. Perhaps the most striking finding in this report is that only a quarter of all eighth graders scored at or above the "proficient" level on the mathematics portion of the National Assessment of Educational Progress test last spring. (The scores fell into four groups, below basic, basic, proficient, and advanced.) For a long-range view of these issues, see David L. Angus and Jeffery E. Mirel, *The Failed Promise of the American High School, 1890–1995* (New York, NY: Teachers College Press, 1999).
41. For the most recent articulation of the famous aphorism (attributed variously to Mark Twain or Benjamin Disraeli), see Joel Best, *Damned Lies and Statistics: Untangling Numbers from the Media, Politicians, and Activists* (Berkeley, CA: University of California Press, 2001), 5.
42. The Oxford English Dictionary, 2nd edition (1989), credits mathematician Lotfi A. Zadeh for the term "fuzzy" in mathematics, dating from 1964. It was in use in the California debate over curriculum reform in 1995, appearing in a *Los Angeles Times* article of December 19, 1995, by Richard Lee Colvin: "Parents Skilled at Math Protest New Curriculum, Schools: Vocal minority, many in technical fields, deride 'fuzzy' teaching. But reformers call them elitist." Lynne Cheney's *Wall Street Journal* article deriding "fuzzy math" appeared June 11, 1997, and it sparked a flurry of other newspaper usages in the following months, according to a LEXIS-NEXIS database search. Bush's debate use occurred on October 3, 2000; Paul Krugman's book was published in May 2001 by W. W. Norton (NY).

The scale of low proficiency literacy and numeracy in the adult population remains an issue for policy makers, particularly given the evolution of the labour market and the growing penetration of ICT in all areas of life. PIAAC is considerably expanding the information available regarding persons with low levels of literacy.Â In addition, people follow individual pathways when searching for information on the Internet and thus create their own â€œtextsâ€, in the sense that the total set of information that each individual encounters is unique. The skills required to use digital information effectively are less well understood than traditional print skills.