Setting Greater Expectations for Quantitative Learning

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To borrow a phrase that has echoed through an era, "The times they are a-changin'."

At the turn of the twentieth century, only about four percent of all Americans went to college. Today, as we enter the twenty-first century, nearly eighty percent of high school students say they would like to go on to higher education and over seventy percent actually do enroll in some form of postsecondary learning within two years of graduating from high school. Many others return to college later in life.

At the turn of the twentieth century, only a few Americans expected to spend their lives engaged in knowledge-based forms of work. Today, creative intelligence is both expected and required at virtually every level of the workplace, from the front desk, to technology-assisted work processes, to environmental analysis and strategic planning. Administrative assistants and executives alike are assessed on their ability to analyze situations, invent appropriate procedures, and solve problems. A healthy percentage of these problems involve numbers.

At the turn of the twentieth century, many key issues were decided, both for the nation and for local communities, by small groups of "leading citizens," i.e., prosperous white men. Our nation's highest court had made "separate but equal" the societal standard and people of color, as well as women, were consistently marginalized. Today, the United States celebrates diversity, and in all quarters of our nation there is a new emphasis on ensuring that every citizen—including those historically excluded—understands and is engaged in the important issues that affect

the quality of our lives together. For this expectation to be anything more than a platitude, every citizen, most especially those historically disenfranchised, needs to develop ease and facility in dealing with complex questions, including questions that come framed in terms of quantitative numbers and arguments.

I offer this list of transformational changes in our expectations about the role of advanced knowledge in our world, not to suggest that we have resolved our historical problems with societal asymmetries—we have not—but to set a social and historical context for the very useful "Case for Quantitative Literacy."

The Way We Were

Ours is indeed a world infused with numbers, as the case statement reminds us. But ours is also a world in which a quite new expectation is emerging that "everybody counts" (National Research Council, 1989). This expectation—which has only recently been articulated—challenges deeply entrenched social and institutional practices invented for a world in which everybody was not expected to count, either literally or symbolically. To support high levels of educational accomplishment for everyone, we need to identify and change those dysfunctional practices. As the case statement explains, the school-based mathematics curriculum has been full of such practices. It bears considerable responsibility for the innumeracy that currently characterizes most college graduates.

When I think about my own experience studying mathematics in high school, it is very clear that the course of study I took—the standard lineup of algebra I and II, geometry, trigonometry—was not designed to teach me to deal with quantitatively framed questions relating to the larger society. In my adult life, as a senior academic administrator addressing complex questions about educational and institutional practice, I deal with quantitatively argued issues virtually all the time. But the truth is, there is no connection at all between the mathematics I took beyond arithmetic and the questions I face as a professional. What I understand about quantitative reasoning in my life's work I have picked up on a need-to-know basis, outside of school.

The mathematics curriculum I took in school seemed rather to have two other dominant purposes. The first was sifting. Could students deal

sufficiently well with abstract analysis and logical problem solving that they would qualify as "college material"? A diligent student, even when solving problems that seemed pointless to my teenage self, I met that entry-level mathematics standard fully. I did well in the required courses, I crammed with review books to ensure a good SAT score, and I happily became part of the top tier that went on, not just to college, but to a "nationally ranked" college. For most of those who were similarly sifted, whether in or out, mathematics courses were mainly a hurdle to be traversed. They were only incidentally about valuable learning.

The second purpose of the mathematics curriculum seemed to me, even then, to be one of sorting. Did the student's grasp of mathematical principles and practices reach a sufficient level that he or she (mostly he) could expect to perform well in the sciences, or even in advanced mathematics itself? I knew very well that I did not come close to meeting that standard. Science and mathematics would not want me; I accepted that.

Once secure in college, aided and abetted by a flexible system of "distribution requirements," I was careful never again to take a quantitatively oriented course. Mathematicians have told me that my youthful perceptions were close to the mark. The mathematics curriculum has indeed had as one of its major functions selecting the small minority of students who can both embrace and thrive in a world of highly abstract and often lonely analysis.

Looking back on my mathematics experiences, I am reminded of a comment made by a student about a lecture class he had taken with over seven hundred classmates. "If they had wanted us to use what we learned," he observed, "they wouldn't have taught it that way."

The case statement makes the same point. If we really wanted all students to use quantitative strategies in their life, it asserts, we would teach them—students and strategies alike—very differently. We would open the curriculum to often-excluded content, including statistics. And we would use context-attentive pedagogical approaches. For most students, after all, "skills learned free of context are skills devoid of meaning and utility." I was a perfect illustration of this argument.

Were I unique, this little tale would be of no interest whatsoever. But in fact my story is all too typical. The world is infused with quantitative questions, yet the standard mathematics curriculum all too frequently produces mathematics avoiders and amnesiacs.

Setting Greater Expectations

What, then, is to be done? How do we meet the new test of ensuring that an entire nation of college-going citizens develops lasting facility in quantitative reasoning? The case statement offers two primary themes—different content, different pedagogies—as a point of departure. What specific educational changes flow from this prescription?

Here are some proposals that respond to this question. They are drawn from a new Association of American Colleges and Universities (AAC&U) education initiative, entitled "Greater Expectations," that seeks to achieve a new intentionality about what it will take to successfully prepare an entire generation—that new majority now flocking to college—for the intellectual and social demands of the contemporary world.

The Greater Expectations initiative focuses on important outcomes of college-level learning, outcomes that are intended more powerfully to prepare students for lives of creative and thoughtful intelligence, professional excellence, and engaged citizenship. The initiative calls for:

1. Articulation of and focus on forms of learning that are widely needed in the modern world.
2. A new intentionality about addressing expectations for student achievement across successive levels of learning, from school through college.
3. Involvement of students in "authentic assignments," i.e., the kinds of tasks that actually develop complex abilities while showing students how those abilities can be used with power in real contexts.
4. Transparent assessments, linked to authentic assignments, that emphasize what students can do with their knowledge rather than their ability to pass standardized tests.
5. Connection of desired capabilities to learning in each student's major, so that study in the major becomes an essential vehicle not only for developing those capabilities but also for learning how to put them to use.

What do these premises imply for fostering quantitative literacy through school and college learning? Here are my proposals for educational change:

- *Create a public and policy dialogue about the uses of quantitative literacy*.

The first change is to identify, as the authors of the case statement have, the ways in which quantitative literacies are actually used in contemporary society. But this should be more than an academic discussion; the case statement could well be used to spark a broader public and policy dialogue about the need to recast and broaden our expectations for the quantitative literacy of the citizenry.

- *Identify kinds of learning*.

The second change is to move beyond typologies of numeracy to a delineation of the kinds and levels of learning that need to be addressed, both in school and college, if students are actually to be held accountable for developing usable capabilities in quantitative reasoning and problem solving. Here again, the discussions should include policy and civic leaders as well as teachers and scholars.

- *Rethink high school mathematics*.

The third change is to acknowledge the need to substantially retool the high school mathematics curriculum as well as the preparation of the teachers who provide that curriculum. High school study must lay a foundation for statistical as well as mathematical understanding. And it needs to incorporate context-rich practices that enable students to learn essential skills and discover why and for what purpose these skills matter.

- *Rethink college quantitative literacy requirements*.

The fourth change is to recognize that, at the college level, no one course of study can realistically develop all the major kinds of quantitative literacies described in the case statement. We need to stop thinking that remedying our quantitative deficiencies is simply a matter of "fixing" mathematics standards and the corresponding curriculum.

- *Encourage alternative pathways*.

Instead—the fifth change—we need to design multiple courses of study, each well structured to foster quantitative strategies used in specific kinds of professional and civic contexts. The analogy, as the case

statement suggests, is to writing. Although all educated people need certain kinds of writing abilities, successful people actually deploy very different rhetorics depending on the context. Scientists, for example, make highly field-specific written arguments; politicians frame their written arguments in very different terms. We should allow college students to develop quantitative strengths keyed to their actual interests, even at the cost of underdeveloping other possible abilities that, realistically, they are unlikely actually to use.

• *Embed quantitative literacy in other fields*.

The sixth change follows from the fifth. It is time to give up on the stand-alone general education mathematics requirement. The great majority of colleges and universities, whether research- or teaching-oriented, still insist that most students take such a course (usually selected from a limited menu of options) as a requirement for graduation. But very little is actually accomplished through this traditional approach to quantitative reasoning and we must fundamentally rethink it. One promising strategy is to make field-related quantitative competence the standard, holding students accountable for evidence of developed ability to actually use quantitative reasoning in ways keyed to their major field(s) of study.

This sixth proposal may give the reader pause. Suppose the student's field of study seems not to require quantitative abilities. What about English, the paradigmatic nonquantitative major?

The tough question is how to bring all fields into dialogue with the modern world. Even as I was majoring in history in the late 1960s, and assiduously avoiding all quantitative courses, my field was actually moving in a decidedly quantitative direction. Most fields, as the case statement reminds us, are becoming more quantitative, reflecting trends in the world at large. All curricula must adapt to these realities. Today many history departments hold students accountable for knowledge of quantitative methods. Tomorrow (or at least in a few years) English departments, already richly infused with sociocultural concerns, must recognize and engage their students' need for quantitative literacy as well.

Moreover, there is a discernible trend on college campuses toward minors and double majors. Colleges might insist that students choose at least one area of concentrated study, whether a major or a minor, that requires and fosters quantitative competence.

Whatever strategy we choose, we must recognize that it really is malpractice to allow students to slip through college without developing the ability to use quantitative strategies to examine significant questions. As the case statement so richly conveys, we are only shortchanging our graduates with respect to the actual demands of a numbers-infused world.

Faculty Work

Lurking beneath all discussions about expectations, curricula, new ways of structuring student learning, and so on are, of course, important concerns about the professional roles of faculty members and about the autonomy and intellectual standing of mathematics departments. No mathematics department wants to see its curriculum cannibalized as each neighboring department incorporates a customized quantitative component. Nor does any mathematics department want to find itself providing only educational "services" to other programs. These are real issues and they cannot be dismissed lightly.

But we are a creative people. Exciting curricular models already abound across the United States in which faculty are linking content courses from different departments together so that students can explore important topics from multiple disciplinary angles. Mathematics is already engaging economics, physics, business, and education. And conversely, most fields are elevating their own expectations for quantitative literacy, raising the possibility of cross-disciplinary collaborations at advanced levels of mathematics rather than in entry-level programs only.

Just as faculty research interests already have blurred disciplinary boundaries, so too curricular innovations can reconfigure the inherited autonomy of departments in intellectually exciting ways. By focusing on contexts, creativity, and new connections across disciplines and fields, scholars who love mathematics may well find new forms of intellectual satisfaction in raising the quantitative literacy of an entire society.

REFERENCES

National Research Council. *Everybody Counts: A Report to the Nation on the Future of Mathematics Education.* Washington, DC: National Academy Press, 1989.