Quantitative Literacy in the Workplace: Making It a Reality

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Business cares deeply about education because the United States can thrive only with a well-educated populace. Indeed, business is deeply invested in improving education for all young people, especially in helping them acquire the increased knowledge and skills required to meet twenty-first-century demands. In this agenda, business is not alone—educators, policymakers, and the general public share the same goal. Despite their concerted effort, however, student achievement remains inadequate. Rather than dwell on disappointment, business leaders and others continue efforts to revitalize education. This essay explores one vital component of the goals for education in the twenty-first century—that of quantitative literacy for all.

Although there is no firm consensus on the meaning of quantitative literacy, there is at least growing agreement that existing practices in mathematics education do not adequately address this competency as it is required in the workplace. Many new jobs demand highly developed computational skills coupled with strong skills in critical thinking, problem solving, and logical reasoning. Moreover, given the increasing pace of technological progress, future jobs will require greater adaptability to new systems and processes: employees must be prepared to apply quantitative principles in unforeseeable contexts. Although the level of sophistication may differ from job to job, the need for adaptability will characterize low-skill as well as high-skill jobs. There is a growing awareness, therefore, that our nation’s young people must master something more complex than the mathematics curriculum as it is now frequently taught.

Absent a widespread understanding of the steps needed to achieve this mastery, however, businesses are unlikely to include any systemic attempts to achieve quantitative literacy. The challenge, then, is how to bring quantitative literacy into the business agenda for education reform.

The Changing World

The competitive pressures of today’s global economy are forcing U.S. firms to restructure the work they do and how they do it. These changes in the workplace frequently demand more from employees than ever before; workers not only must be able to read, write, and use mathematics but they also must have strong problem-formulation and problem-solving skills. In 1950, for example, 80 percent of jobs were classified as “unskilled,” whereas an estimated 85 percent of jobs today are classified as “skilled.” Decisions once reserved for management—including how to organize responsibilities,
how to improve procedures and increase profitability, how to maintain quality control—are now also routinely expected of nearly all employees.

Unfortunately, the U.S. labor force is not always poised to meet these changing expectations. An annual survey by the American Management Association, released in May 2001, indicated that 41 percent of the responding companies require basic skills tests of job applicants, with slightly more testing in mathematics than in reading. Eighty-five percent of these companies indicated that they do not hire skills-deficient applicants. The 2001 results showed that more than one-third of job applicants tested in reading and mathematics lacked the necessary skills to perform even entry-level jobs. In particular, the assessment of spreadsheet and database management skills—attributes of quantitative literacy—identified 26 percent of the applicants as lacking the necessary knowledge and skills.2

The corporate community has reacted to these findings in an effort to develop a workforce qualified for jobs along the skill spectrum:

- Business leaders have made significant investments in training programs. Training Magazine reported that in 1999, nearly $62.5 billion was spent on training.3 Although exact allocations are difficult to document, anecdotal information suggests that a substantial portion was spent helping employees master basic skills that they should have acquired in high school, thus effectively forcing business to pay for our schools’ failure to educate some members of the workforce.

- Despite challenging political odds, the business community successfully lobbied Congress to enact H-1B visa bills enabling the entry of nearly a million temporary, nonimmigrant, highly skilled computer workers between 1998 and 2004. Lawmakers were persuaded that jobs would otherwise go unfilled by an American workforce lacking the necessary expertise, thus endangering U.S. competitiveness in the global economy.

Projections about future needs only heighten corporate concern. An estimate that 60 percent of all new jobs in the early twenty-first century will require skills possessed by only 20 percent of the current workforce is one such cause for alarm.4 Similarly, projections that 20 million jobs will be added to the U.S. economy by 2008 have raised questions about the vitality of the educational pipeline to support such growth.5 Although the full impact and length of the current economic downturn are not yet clear, the business community is paving the way for future growth even as it takes steps to deal with existing challenges.

Corporate Involvement in Education

These signs have persuaded the business community to adopt a proactive, rather than reactive, stance on education. Instead of relying only on remediation or recruitment abroad, business leaders are increasingly committing themselves to improving U.S. education: that is, to raising the knowledge and skill levels of all young people prior to their entry into the workforce. Business leaders do not expect the need for specialized training to diminish, given the technology-driven workplace in which the only constant is change. But they do expect that adult workers no longer will be impeded in their acquisition of new knowledge by lapses in their understanding and mastery of prior knowledge. Here are five examples of major business-led reform efforts.

State Reform

Advocacy: In collaboration with the nation’s governors, over the past five years several CEOs6 have served as members of Achieve, Inc., including participation in four national education summits. These corporate leaders have committed themselves and their companies to improving student achievement, increasing investments in and accountability for teachers, and promoting regular assessments that are comparable across schools and districts.

Implementation: The business community—through state and local business coalitions—plans to work with state education officials to implement No Child Left Behind, the reauthorized Elementary and Secondary Education Act (ESEA). These efforts may include dissemination of information about the legislation, mobilization of business leaders to participate in strategic planning, identification of effective practices for business involvement, and providing public officials with the business perspective on roadblocks and implementation successes.

Influencing Federal Policy

K–12 Education: In January 2001, over 70 leading U.S. corporations and business organizations from across the economy formed the ad hoc Business Coalition for Excellence in Education (BCEE) to work with the president and Congress on the reauthorization of the ESEA. Guided by a set of 10 policy principles, leading CEOs presented a unified business voice on recommended legislative language to help ensure that an effective bipartisan bill was signed into law. These principles offer a road map of the educational issues that are most important to the business community. (See the Appendix for a complete list of the principles.)

Postsecondary Education: With the reauthorization of the Higher Education Act, the Workforce Investment Act, and the Carl D. Perkins Vocational and Applied Technology Education Act scheduled for the next session of Congress, the business community will likely again coalesce around a set of principles to guide its recommendations for shaping the legislation.
ENHANCING THE TEACHING PROFESSION

In 2001, four business organizations—the Business Roundtable, the National Alliance of Business, the National Association of Manufacturers, and the U.S. Chamber of Commerce—released a report entitled Investing in Teaching. Calling for a renaissance in teaching, the report describes:

- A new model of teacher preparation and professional development;
- A new model of teacher pay tied to performance and a new employment compact; and
- A new school environment that provides teachers with the freedom and flexibility to achieve results.

The business community is now partnering with educational leaders, policymakers, and other stakeholders to bring these models to fruition.

INDIVIDUAL COMPANY INITIATIVES

Individual companies invest significant resources and staff to provide grants, scholarships and fellowships, and executives-on-loan, among other options, to programs at the national, state, and local level. To name just a few:

- The Johnson & Johnson Bridge to Employment program provides mentoring opportunities, internships, job shadowing, teacher externships, guest lecturers for high school science classes, and curriculum development in eight communities across the country.
- Micron Technology devotes considerable staff time and energy to K–12 programs that demonstrate the importance of mathematics to twenty-first-century careers.
- Charles Schwab offers conferences for student attendees to learn about quantitative literacy in the finance industry. A keynote speaker and various professionals typically describe their jobs and what is takes to be successful in their careers.

SETTING BENCHMARKS

The American Diploma Project (ADP), recently launched by Achieve, the National Alliance of Business, the Fordham Foundation, and the Education Trust, has three goals:

1. To develop and solidify demand—from higher education and employers—for standards-based high school assessment data in admissions and hiring processes;
2. To assist states in revising and/or strengthening their current standards-based systems; and
3. To develop national high school graduation benchmarks in English language arts and mathematics that all states may use to calibrate the quality and rigor of their standards and assessments.

Through this project, the business community seeks to identify, among other skills, the quantitative literacy that is fundamental to success in the workplace. The intent is to define benchmarks in terms of academic skills and courses that must be mastered in secondary school.

IMPLICATIONS

These business initiatives all address education, yet only the last one overtly addresses quantitative literacy, and then only in the context of school mathematics. Although the business community has demonstrated its sincere and long-standing commitment to education reform, the issue of quantitative literacy is almost absent from its education agenda. Furthermore, business leaders are not looking for new issues to champion, especially when substantial progress on existing issues remains elusive. Advocates for greater quantitative literacy, therefore, cannot expect business to take any position on the issue—much less to promote it in its principles for education reform—unless they themselves raise business awareness of the issue’s importance. To do so, they first have to formulate a useful definition of quantitative literacy, one that clearly addresses the business demand for necessary knowledge and skills and one that is widely understood.

What Is Quantitative Literacy?

THE BUSINESS PERSPECTIVE

What does the phrase “the business perspective” mean? Clearly, the business community is not monolithic and we must always use caution with generalizations—perhaps even more caution when describing an issue such as quantitative literacy, which has yet to receive widespread attention from the business community.

When asked to describe quantitative literacy, a quality manager from General Electric characterized it as “the ability to conceptualize work, identify metrics for gathering data, and understand how to utilize data to take action to improve performance.” By contrast, the head of organizational development at Quaker State Penzoil characterized it simply as the ability to apply “basic addition, subtraction, multiplication, and division skills to various situations on the job.” A study of the skills and competencies needed in the environmental technologies industry contained aspects of both these characterizations.
Mathematics as applied in the workplace, and mathematics as taught in schools and colleges, can be very different. Most mathematics problems in the workplace involve applications of what is typically referred to as “basic arithmetic,” i.e., addition, subtraction, multiplication, and division. However, these problems can vary considerably in their complexity and associated levels of mathematical reasoning. Many jobs require complex, high levels of mathematical reasoning, even though they do not require high level mathematical concepts found in geometry, trigonometry, or calculus. For example, adding production figures is very straightforward, but knowing when and how to calculate the average production for the day is more difficult; it is a two-step mathematical calculation and requires knowing both what an average is as well as how it is calculated. Even more complicated is understanding how and when to take into consideration scrap or waste, in order to calculate “net” production. . . 8

Are these conceptions necessarily different? While GE emphasized reasoning, Penzoil emphasized computation, two facets of current workplace responsibilities and of quantitative literacy. And, although the environmental technologies illustration unites reasoning and computation, it employs the word “mathematics” rather than quantitative literacy.

This is not to argue that the representatives of GE, Penzoil, or the environmental technologies industry agree or disagree about quantitative literacy. Indeed, the assertion of active agreement or disagreement implies far more awareness and discussion of quantitative literacy than currently exists in the business community. There is, in fact, no shared business-wide vocabulary about the issue, or a consensus on what constitutes quantitative literacy. Yet, progress in building a more quantitatively literate workforce depends on such consensus. Many businesses successfully “reinvented” themselves over the past decade by a deliberate process of change management motivated by a clear vision of new goals. Without such a clear, quantifiable vision, many business leaders hesitate to pursue change.

Although the business community has thus far shown little interest in developing a widely shared understanding of quantitative literacy, there are admittedly workplace efforts underway that could yield a common definition, perhaps by inference, perhaps as an unintended by-product.

Assessing Skills for Employment Readiness: The American College Testing (ACT) WorkKeys® program 9 offers a set of scales developed so that:

- Students and workers can document and advance their employability skills; and
- Educators can tailor instructional programs to help students acquire the skills employers need.

Yet the WorkKeys “Applied Mathematics” scale is primarily arithmetic, with virtually no reference to the reasoning skills sought by the GE quality manager. Although this scale might be appropriate for some entry-level jobs in some industries, its usefulness across the economy has not yet been demonstrated. Thus, its utility as the basis for a workplace definition of quantitative literacy is questionable at best.

Skills Standards: The National Skills Standards Board (NSSB) was created in 1994 to “build a voluntary national system of skill standards, assessment and certification systems to enhance the ability of the U.S. workforce to compete effectively in a global economy.”10 These standards were intended to define the work to be performed, how well the work must be done, and the level of knowledge and skill required. Although a description of quantitative literacy in the workplace might emerge from this initiative, this potential is far from being realized, because:

- The rate of change in the workplace has outpaced the development of the standards, rendering them almost obsolete by the time of release.
- The “least common denominator” often emerged from the process of developing standards, with the corresponding result of scant buy-in from different constituencies in the workplace.

The Education Perspective

In contrast to the business community, education groups offer more concrete definitions of quantitative literacy, even though they sometimes refer to these definitions under the rubric of “mathematical literacy.”

One important definition serves as a foundation for the Programme for International Student Assessment (PISA), a first-of-its-kind international study of 15-year-old students’ ability to apply reading, mathematics, and science literacy in real-world contexts. PISA characterizes mathematics literacy as “an individual’s capacity to identify and understand the role that mathematics plays in the world, to make well-founded mathematical judgements and to engage in mathematics, in ways that meet the needs of that individual’s current and future life as a constructive, concerned, and reflective citizen.”11
In *Mathematics and Democracy: The Case for Quantitative Literacy*, the National Council on Education and the Disciplines outlines several elements of quantitative literacy:

- Having facility with simple mental arithmetic; estimating arithmetic calculations; reasoning with proportions; counting by indirection;
- Using information conveyed as data, graphs, and charts; drawing inferences from that data; recognizing disaggregation as a factor in interpreting data;
- Formulating problems, seeking patterns, and drawing conclusions; recognizing interactions in complex systems; understanding linear, exponential, multivariate, and simulation models; understanding the impact of different rates of growth;
- Understanding the importance of variability; recognizing the difference between correlation and causation;
- Recognizing that seemingly improbable coincidences are not uncommon; and
- Using logical thinking; recognizing levels of rigor in methods of inference; checking hypotheses; exercising caution in making generalizations.

**Implications**

Attainment of quantitative literacy requires the ability to reason, to make sense of real-world situations, and to make judgments grounded in data. The description of lifelong literacy—“learning to read” and “reading to learn”—could provide a good model for the development of a similarly effective characterization of quantitative literacy. This model must capture the notion that people who acquire quantitative literacy gain a foundation for future learning, one that enables them to adapt to the demands of an increasingly technological world.

Still, the business and education communities have yet to close ranks around a single, well-known conception of quantitative literacy that could motivate a reform agenda advocated by both parties. What is emerging, however, is a consensus that there is something new needed by an educated adult, something more than arithmetic proficiency. Business leaders are seeing the problem; they have not yet seen the solution.

**Who Needs Quantitative Literacy?**

Rapid technological change has dramatically altered the American business landscape. The invention of the microprocessor, with its ability to move vast amounts of information, has prompted a technological explosion. Innovations stemming from more advanced technology, remote satellite communication systems, fiber optic cables, encryption, biotechnology and genomic discoveries, laser scanners, and the Internet have launched the marketplace in multiple, often uncharted, directions. As a result, a company’s competitive advantage rests with its workers’ ability to interpret data, make decisions, and use available technology. This is true, to some degree, of almost all jobs along the skill continuum, even though each calls for different levels of quantitative literacy.

Although some jobs are becoming more complex, computers and related technologies are simultaneously eliminating many traditional jobs. With the assistance of technology, one person, in dramatically less time, now can accomplish tasks that once were carried out by a team of people. ATMs have replaced bank tellers, on-line databases have replaced travel agents, and computer-operated machines have replaced factory laborers.

**Job Growth and Decline**

Projections from the Bureau of Labor Statistics for 1995—2008 confirm that the majority of shrinking occupations are those that are being replaced by technologies. Jobs performed by installers or operators are in the greatest decline: typesetting machine operators, railroad brake and signal machine operators, peripheral equipment operators, sewing machine operators, machine tool cutting operators, woodworking operators, and switchboard operators. Office automation and the increased use of word processing equipment by professionals and managerial employees also have led to a decline in individually paid word processors and typists, proofreaders and copy markers, payroll and time clerks, bank tellers, and bookkeeping and auditing clerks.

The four fastest growing occupations—computer engineers, computer support specialists, systems analysts, and database managers—demand strong mathematical skills, complex problem solving, a facility with the use of technology, and the ability to evaluate data to anticipate future challenges. In other words, they require quantitative literacy.

Desktop publishing specialists and legal assistants, the next two fastest growing occupations, also follow this pattern. Incumbents in such jobs must have the ability to use technology to record and represent data and the ability to think logically and implement multilevel solutions to problems.

Other projected high-growth occupations require quantitative literacy. Home health aides, medical assistants, social and human service assistants, and physician assistants—often thought of as low-skill workers requiring a minimum of formal education—need to think logically and devise multilevel solutions to complex problems. Such skills, especially in health care, require significant
quantitative skills as a frame of reference for administering correct dosages of medicine, gauging physical reactions, and judging the interaction of various treatments.

**Implications**

Although gainful employment is not the sole purpose of education, it is a necessary and expected outcome. Education therefore must be influenced by changes in the workplace. That some types of jobs disappear and new ones emerge is certainly not a new phenomenon; neither is the fact that education evolves to reflect the changing employment market.

The accelerating rate of change in the workplace, however, heightens the challenge. Mathematics education reform in the late 1980s criticized the lingering vestiges in school mathematics of a “shopkeeper curriculum” left over from the previous century for a nation no longer dominated by shopkeepers. We cannot afford the luxury of such a slow response, if we ever could.

The pervasiveness of quantitative literacy among jobs showing the greatest growth—and the reasonable assumption that the trend will continue—requires the education system to respond accordingly by incorporating quantitative literacy into schooling. In its frequent calls for “critical thinking” abilities or “real-world” skills, the business community has long been moving toward something resembling a conception of quantitative literacy. Still, a vast gulf separates this intuitive sense of new skill requirements from the advocacy of education reforms that can actually result in a quantitatively literate citizenry.

**What Is Business Doing to Address Quantitative Literacy?**

The answer is simple—not enough.

**In Education**

Business involvement in education, as described earlier, is focused on policy. Calls for higher student achievement are often accompanied by calls for rigorous course work. What should comprise that rigorous course work—in mathematics or any subject—is not discussed in detail. Instead of addressing specific pedagogical or curricular questions in which it has little expertise, the business community focuses on broader issues in terms of outcomes:

- Algebra for all students;
- A world-class secondary school curriculum, as defined by the Third International Mathematics and Science Study (TIMSS); and
- A widening of the pipeline for scientists and engineers.

Although laudable, these recent business-led efforts to improve student achievement in mathematics do not necessarily advance the cause of quantitative literacy. Certainly, the business community’s long-standing call to align curriculum, assessments, and teacher preparation with high-quality, rigorous academic standards promises to bring about much-needed gains in student achievement. Real progress toward widespread quantitative literacy, however, will require even more fundamental changes.

**In Business**

Even in their own employee training programs, businesses do little to encourage quantitative literacy.

**Effectiveness:** Reports from the American Society of Training and Development, The Work in Northeast Ohio Council, and the National Association of Manufacturers indicate that training programs are effective—up to a point.\(^\text{14}\) These studies provide evidence that corporate training programs can improve employee performance, firm productivity, product quality, and even company profitability. Indeed, such evaluations help business justify the expenditure. Over the long term, however, such gains in productivity and profitability will inevitably remain limited as long as the training is restricted to narrowly defined skill areas.

**Course Content:** Two types of corporate training programs—remedial and computer-based—could, but apparently do not, include quantitative literacy. Remedial programs tend to teach basic arithmetic and fail-safe formulas with little emphasis on problem solving. Employees are rarely taught to identify quantitative relationships in a range of contexts and settings, to consider a variety of approaches to manipulate those quantitative relationships, or to make data-based decisions on the job. As a result, few employees acquire even rudimentary quantitative literacy on successful completion of such a program.

With businesses incorporating more technology into their daily operations, the majority of workplace training—both formal and informal seminars—is computer related. Indeed, according to *Training Magazine*, nearly 40 percent of all workers receive formal training from their current employers.\(^\text{15}\) These classes run the gamut from the use of spreadsheets to the use of advanced statistical analysis software such as SPSS.

Despite this universal access to computer training, such classes apparently have little impact on quantitative literacy. Existing computer training programs may fail to build strong quantitative literacy because they devote scant attention to the connection between computer applications and real-world scenarios. Because accessing technology does not necessarily depend on a person’s ability to reason with the inputs or results, very few computer-related training courses are contextualized. Consequently, train-
ing providers focus their instruction on algorithmic usage at the expense of exploring the power of technology and the ways in which it can be applied in a variety of situations. The end result: workers gain only rudimentary knowledge of quantitative literacy through use of computer technology.

**IMPLICATIONS**

The candid answer to the question—What is business doing to address quantitative literacy?—remains: apparently very little, at least little that consciously addresses the challenge.

We could attribute this inaction to uncertainty about effective ways to broaden training or to participate meaningfully in educational discussions about curriculum. There could be a reluctance to invest the time and money without a clear means of measuring results. Business might be dismayed by the lack of a clear course of study that leads to quantitative literacy, or by many other training issues competing for attention and support in the business world.

Moreover, there is no clear leverage point to rally around. When students are not yet achieving at acceptable levels in traditional course work, the prospect of fighting for a new, somewhat amorphous concept with far-reaching curricular implications is daunting.

Most important, business leaders routinely measure investments of time, resources, and commitments against the potential “return on the investment.” Without a clear understanding of the means and ends of quantitative literacy—the ways in which young and adult learners acquire the knowledge and skills, and the payoff for such acquisition—business will not likely make any serious investment.

This is not cause for discouragement but rather a window of opportunity.

**Setting Greater Expectations**

There is no better way to improve business’ chance for success than by developing well-prepared, job-ready workers who think on their feet, learn on the job, and take on new challenges. Although these qualities may be commonplace among the highest tier of employees in innovative industries, they do not characterize the workforce writ large.

Our failure to produce a more quantitatively literate workforce presents our nation with an important civic and economic challenge. The business community has a critical role to play in assisting educators and the public in restructuring education in response to the needs of the modern workplace and the requirements of today’s society. If we want to promote a palpable increase in quantitative literacy, we must adopt an aggressive strategy designed to improve the knowledge and skills of the current and future workforce.

The following six action steps provide corporate America with a blueprint for meeting this challenge:

1. **Participate with education and workplace researchers to better document the existing level of and anticipated need for quantitative literacy in the workplace.**
   The vibrancy of the U.S. economy—despite the recent downturn—and the high level of innovation throughout history suggests that there has always been a cadre of people with the necessary skills and verve. Yet, a greater proportion of the workforce needs quantitative literacy to sustain and grow business in the twenty-first century.

   There seems to be little readily available data that could inform new policies to support broader acquisition of quantitative literacy. This is ironic, because in such a data-driven field, experts who promote quantitative literacy apparently have not gathered the ammunition to support the need expressed in their rhetoric.

   Without data, questions pivotal to policy decision making end up unanswered. For example: What proportion of the population lacks quantitative literacy skills? What proportion of jobs requires quantitative literacy? What can business expect as a return on investment for implementing quantitative programs? Is it more cost effective to achieve quantitative literacy through the educational pipeline or through workplace training or through both? What are the educational characteristics of programs that would yield quantitative literacy?

   The inability to answer such questions has impeded, and will continue to impede, progress in developing realistic options and programs that demonstrate results.

2. **Work with schools and colleges and among companies to raise general awareness about the importance of quantitative literacy in today’s workplace.**
   Most businesses do not recognize quantitative literacy in the workplace, making it difficult to design and support efforts to increase it. Because many use computational capabilities as a proxy for quantitative skills, they often develop and support educational programs that may rest on faulty assumptions. Quantitative literacy may even manifest itself differently from industry to industry, from occupation to occupation, from task to task, further complicating the situation.

   As more data about quantitative literacy are gathered, and businesses analyze the demand for quantitative literacy in the workplace, they will be better equipped to formulate a cogent message
to students, employees, educators, policymakers, and peer companies about the true implications of quantitative literacy in today’s workplace. Such a public information campaign is needed to institutionalize quantitative literacy as a fundamental goal of the educational pipeline.

Because some information about workplace skills is proprietary and may bear on a company’s competitive advantage in the marketplace, impartial business organizations and researchers may be best positioned to aggregate data on quantitative literacy and share it among interested stakeholders. A broad group of stakeholders, however, should work together to raise the level of awareness and understanding of quantitative literacy.

3. Provide leadership and support to achieve quantitative literacy among elementary and high school students.

A specific and workable conception of quantitative literacy should provide a foundation for long-term initiatives to improve U.S. secondary school education.

Ultimately, the typical business manager has a right to be perturbed when he or she pays twice to educate an employee—first through taxes for public education that did not fully succeed, and again through direct expenditures for that employee. While recognizing the need to shore up the skills of the current workforce, business must promote improvement in public schools as a means of increasing the skills of future generations.

Indeed, this need to promote improvement must extend beyond mere advocacy for higher standards to include a call for fundamental reforms to the way we teach mathematics. Business leaders regularly argue that even students who perform well in mathematics courses are often not prepared to function effectively in today’s workplace because they lack versatility and flexibility in dealing with real-world obstacles. They become stymied by challenges for which there are no prescribed textbook solutions. Young people must learn this versatility and flexibility in school, long before they enter the workforce.

Business is particularly well equipped to make a powerful case for quantitative literacy in elementary and secondary schools, but first it must acknowledge that widespread quantitative literacy will not necessarily result from requirements that students take more mathematics courses. To effect more meaningful changes over the long term, business must become more fully engaged with the content and delivery of those courses.

4. Engage education and training partners to help upgrade the quantitative literacy of the workforce based on identified quantitative needs.

Although efforts to create a new generation of quantitatively literate Americans will promote a stronger economic future, the business and education communities cannot simply write off the current generation of workers. Businesses should capitalize on and modify existing training infrastructures to produce a more quantitatively literate workforce.

Large corporations are centralizing their education and training functions under a “Chief Learning Officer” (CLO) to bring a sense of strategy, purpose, and efficiency to far-flung educational and professional development functions. In such corporations, economies of scale allow this specialization of the CLO. Of course, the vast majority of U.S. companies are small and do not have the resources to conduct detailed job task analyses nor the expertise to choose the right mix of course work for their employees. There is no shortage of vendors and salespeople plying their wares to the small-business owner or human resources director. Unless there is a clear, functional skill needed by employees, however, a harried manager is likely to avoid the subject of education and training altogether.

Yet a small company may be able to gain access to external expertise by tapping the resources of a local small-business resources center, community college career development center, or continuous education division of a local college or university. These organizations not only offer specific training courses but they also can link a small business to planning and assessment tools, and possibly management consultants, who can help map out a company-wide employee development plan, which should include a focus on the range of quantitative literacy needed by employees. No matter what means they use, businesses must ensure that the planned curriculum is consonant with something more than arithmetic proficiency.

5. Invest Money Wisely and Measure Return on Investment.

Business needs to know that the money it invests is providing the skills that workers need. Whether this investment targets young people prior to employment or broadens and deepens their knowledge thereafter, business will rightfully insist on frequent measures of success. Increasing global competition and mounting educational challenges demand wise corporate investments that demonstrate educational achievement and workforce quality. Thus, employers must engage in regular, meaningful evaluation of their efforts.

6. Develop a Road Map for Continuous Improvement.

To create a mechanism for gauging the return on its investment, business requires an ambitious yet reasonable plan for improvement. If it simply strains after lofty goals, it will certainly fail. And it will—just as certainly—abandon the effort.

Rather, business leaders and educators must establish a succession of clear and attainable objectives, all of which must lead to the ultimate goal of ensuring that every U.S. citizen achieves a high level of quantitative literacy. Piecemeal success does not necessar-
ily add up to a measurable national improvement—every localized initiative must support a much larger vision.

As Intel CEO and President Craig Barrett argues, the processes of continuous improvement common in the business world also can promote successful education reforms. To advance the cause of quantitative literacy, such processes must ultimately incorporate all the action steps described above into what Barrett, quoting W. Edwards Deming, calls a “plan-do-check-act” cycle.16

Advocates for quantitative literacy must first plan: define and measure the problem and then formulate a plan for addressing it. Then they must do: implement the plan in both schools and workforce training programs. Next, they must check: monitor the plan’s results according to preestablished criteria for success. Finally, they must act: on the basis of these results they must enact targeted changes to the original plan. Then the process begins again, at a higher level. By learning from their mistakes while capitalizing on their achievements, reformers can make incremental but significant progress toward the goal of quantitative literacy for all Americans.

Unless business leaders and educators work together to develop a road map for achieving this goal that is at once visionary and practical, the cause of quantitative literacy will not move forward with the speed and resolve required in a competitive global economy.

Conclusion

The jobs of the twenty-first century are more complex than ever before. Technologies such as computers, e-mail, faxes, and the Internet have created a world awash in data. To succeed in this data-drenched society, employees need to have tools to make sense of information in faster and cheaper ways than heretofore. The notion of quantitative literacy promises to offer a mechanism for making sense of this world.

The principles advanced in this essay cannot provide any immediate or easily implemented solutions to the shortage of quantitatively literate citizens. Rather, they call for a committed and sustained effort to specify emerging needs for new quantitative skills, and then to rally stakeholders around carefully targeted programs addressing these needs. Although such an effort presents great challenges, it promises even greater rewards. If they work together toward clearly articulated goals, the business and education communities will have an unprecedented opportunity to prepare every U.S. citizen for success in a constantly changing world.

Appendix

Business Coalition for Excellence in Education: Principles for K–12 Education Legislation

In a world of global competition and rapid technological advances, U.S. schools must prepare all students for the challenges and opportunities of the twenty-first century. To achieve this goal, our school system must adopt higher standards, use high-quality assessments aligned to these standards, and hold schools accountable for results, so that all students have the opportunity to succeed. Federal investments must help each state implement a standards-based, performance-driven education system that is carefully aligned to the goal of higher student achievement. The Business Coalition for Excellence in Education* urges Congress to enact bipartisan legislation that embodies the following principles:

Achieving Systemic Reforms

- **Standards:** All states should have high-quality, rigorous academic standards that reflect the levels of student achievement necessary to succeed in society, higher education, and the workplace. The federal government should provide all states with the information and resources to develop, continuously improve, and benchmark rigorous academic standards that can be used to raise individual student performance to world-class levels.

- **Assessments:** All students should be tested annually with high-quality assessments aligned to state standards. The purpose must be to measure the progress of school, teacher, and student achievement against standards and to identify where additional support is needed for students to reach them.

- **Student Achievement:** Assessments should be used as diagnostic tools to ensure that all students, particularly those identified as under-performing, receive the assistance they need to succeed in reaching high academic standards. Similarly, federal leadership should ensure that preschool aid focuses on helping prepare children to enter school ready to learn.

- **Accountability:** States, districts, and principals should ensure that all students, including disadvantaged and under-performing students, meet high academic standards. States should have policies of rewards and sanctions to hold systems accountable for improving the performance of students, teachers, and principals. Such policies should be based on performance, including student achievement.

* An ad hoc coalition of leading U.S. corporations and business organizations that support these principles in the reauthorization of the Elementary and Secondary Education Act
• **Flexibility**: States, localities, and schools should have flexibility for their educational organization, innovation, and instruction while being held accountable for raising student achievement.

• **Alignment**: States must ensure that high-quality assessments, accountability systems, teacher preparation and training, and curriculum are aligned with high state standards so that students, teachers, parents, and administrators can measure progress against common expectations for student achievement.

• **Data, Research, and Best Practices**: Student achievement data should be collected regularly, and made public in formats that can guide the decision-making of teachers, parents, and students to improve performance. Research must be pertinent to standards-based education systems to enable teachers to apply proven findings in the classroom.

### Areas of Special Focus

• **Math and Science Excellence**: Efforts must be undertaken to increase significantly the number of skilled math and science teachers in K–12 by substantially improving the quality of their preparation and professional development and by expanding recruitment incentives. Investments must focus on raising student achievement in math and science by encouraging the use of world-class educational materials and instructional practice.

• **Teacher Preparation and Training**: It should be a national priority to increase significantly the quality, professionalism, and career opportunities within teaching. States should ensure that teachers have the necessary skills and expertise in the content areas in which they teach. They should ensure that teacher preparation and professional development programs include training to integrate relevant technologies into the classroom. Professional development programs should include principals.

• **Technology**: Technology and the Internet must be integrated into all appropriate aspects of teaching and learning to improve students’ twenty-first century skills as well as educational accountability and administrative effectiveness. Aid should be provided to states and districts to help identify, acquire, and utilize the best available technology and to help teachers integrate it into the curriculum.

### Notes


6. To date, the CEOs from Boeing, Eastman Kodak, IBM, Proctor & Gamble, Prudential, State Farm, and Williams have served on Achieve. Other executives—from Bristol-Myers Squibb, Pfizer, Washington Mutual, to name a few—have attended the meetings as guests.


11. See http://www.pisa.oecd/pisa/math.htm. Although the United States scored near the international average in the mathematical literacy part of the 2000 PISA examination, students in eight countries—Japan, Korea, New Zealand, Finland, Australia, Canada, Switzerland, and the United Kingdom—significantly outperformed American students. Results such as these underscore the urgency of developing a more quantitatively literate citizenry as a means of preserving our long-term economic competitiveness.


