Chapter 9

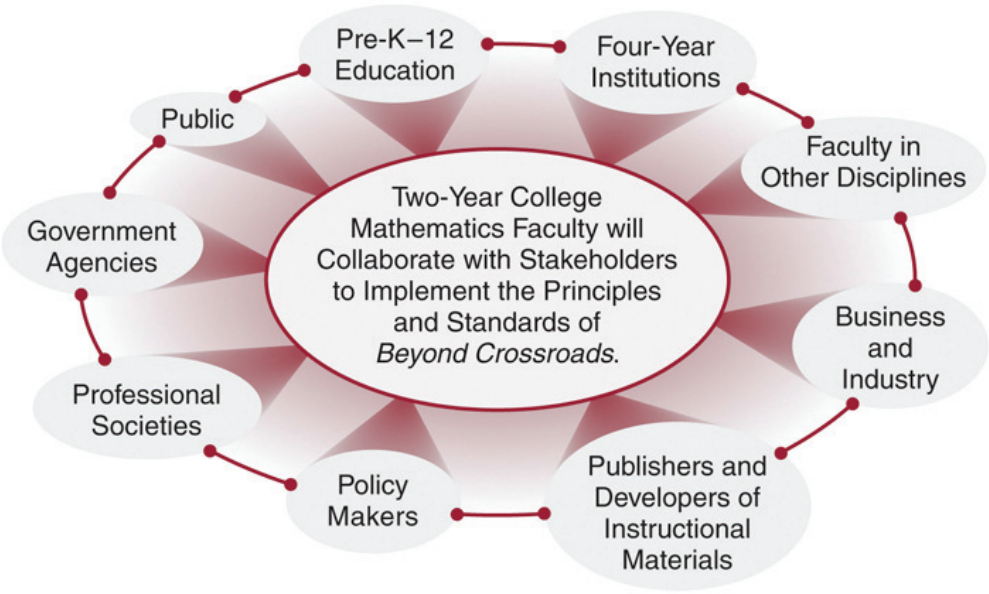
Involvement of Stakeholders in Implementation

The complex issues of learning, assessment, curriculum, teaching, and professionalism can only be fully addressed through actions of all stakeholders, not just a single individual or a single entity. Faculty at two-year colleges need to work with their institution and other faculty, departments, institutions, and stakeholders to improve mathematics programs in the first two years of college to influence and enhance mathematics education for all students and to respond to the mathematical needs of the community. The principles and standards outlined in this document are best served when two-year college mathematics faculty and institutions collaborate with the following entities:

- the mathematics community to build public understanding of and support for improvements in mathematics education
- pre-K–12 institutions and four-year institutions to align exit and entrance requirements, instructional strategies, and curricula
- faculty in other disciplines to infuse mathematics across the curriculum
- publishers and developers of instructional materials to create standards-based instructional resources
- business and industry so that desired employee skills and strategies for achieving them are outlined and incorporated into mathematics courses and programs
- professional societies, government agencies, and educational institutions to build consensus and provide guidance to practitioners

The vision of *Beyond Crossroads* includes an action plan. The activities of the plan are led by mathematics faculty at two-year colleges collaborating with all stakeholders to improve student learning in mathematics in the first two years of college. Implementing the standards requires the involvement of a mathematics community, functioning purposefully as a whole to improve student learning in mathematics. "Systemic change requires new forms of partnerships to make the system more productive and to provide solutions that cut across the system components."[1] Inherent in such collaborative relationships is a willingness to work together to build consensus and a commitment to put standards into practice with systemic actions. The principles and standards of *Beyond Crossroads* are put into action by two-year college mathematics faculty collaborating with the stakeholders shown in the following figure.

Figure 4 Collaborating with Stakeholders

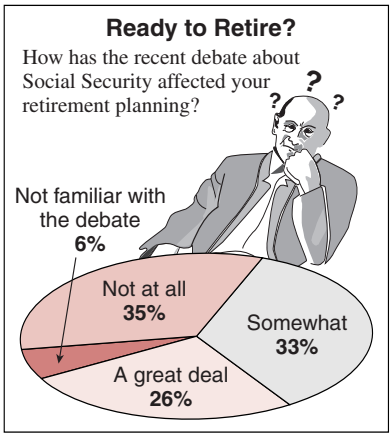


Building Public Understanding and Support

The general public can play an important role in improving mathematics education in the United States. However, in order to help the public understand the many challenges facing mathematics faculty, the mathematics community needs to actively communicate the critical role of quantitative literacy for all citizens and the reasons for changes in mathematics classrooms. "Math literacy—and algebra in particular—is the key to the future of disenfranchised communities... ."[2] The ability to reason analytically and do mathematics impacts on the following:

- an individual's career options in a global and technological society
- a consumer's ability to make decisions and solve problems (e.g., comparison shopping for a car loan or mortgage loan
- a citizen's ability to choose between various policy options (e.g., comparing environmental options and where to use limited funds).

Figure 5



Many technical careers require significant application of mathematics. Employees in business, industry, and government are expected to apply mathematics skills and concepts when making informed decisions and then use the language of mathematics to communicate those decisions. Describing and interpreting data requires mathematical analysis, representations, and manipulations, although the users seldom identify themselves as "doing" mathematics. As many businesses and industries experience a shortage of technically trained workers, these workers are being recruited from overseas or the work is completely outsourced overseas. To be economically competitive and secure, the United States needs citizens who are mathematically literate and capable of filling these jobs.

Acquiring quantitative skills and mathematics power is essential, not optional. Quantitative thinking is a daily activity. Teaching professionals need to recognize that local and national newspapers, news magazines, and professional journals expect their readers to read and interpret tables, graphs, and charts, as Figure 5 shows. An informed citizen should understand mathematical statements such as "The margin of error is plus or minus 5%." Analyzing data and evaluating the validity of claims require quantitative thinking and

mathematical reasoning. The public needs to understand the nature and scope of mathematics today and the importance of quantitative literacy for all.

In addition, research about how students learn mathematics and the rewards of active student learning needs to be shared beyond the classroom. Many students and parents are suspicious of innovative or new teaching methods and the use of technology. The mathematics community must recognize these suspicions and communicate the results of research that show the benefits of active student learning, the use of technology, and alternative delivery formats.

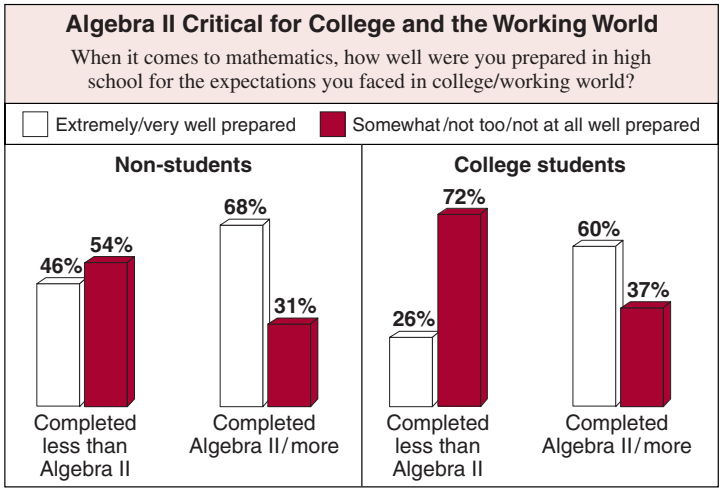
Implementation recommendations to build public understanding and support:

- The mathematics community will communicate the nature and scope of mathematics and the importance of quantitative literacy to the public and share the results of research on the learning and teaching of mathematics with the public.
- Mathematics faculty and mathematics organizations will listen to, analyze, understand, and address the public's questions and concerns about mathematics education and quantitative literacy and will provide opportunities for parents, faculty from other disciplines, administrators, and public officials to gain a deeper understanding of the benefits of standards-based mathematics instruction.
- The mathematics community will seek opportunities to provide input on mathematics used in public interest media.

Connecting with pre-K–12 Education

Dialogue and collaboration between pre-K–12 school districts and institutions of higher education are essential to develop and maintain a consistent, positive, and significant mathematical experience for all students. Institutions that collaborate benefit from each others' resources. Two-year college faculty can learn from middle and high school faculty who use integrated curricula. Two-year college teacher preparation programs can benefit by incorporating pre-K–12 classroom experiences into their courses.

Figure 6



How Prepared Are Public High School Graduates?/Hart Research & Public Opinion Strategies for Achieve, Inc.

"The academic intensity of the student's high school curriculum still counts more than anything else in precollegiate history in providing momentum toward completing a bachelor's degree."[3] And while taking more mathematics in high school is critical, "It's not merely getting beyond Algebra II in high school any more. The world demands advanced quantitative literacy, and no matter what a student's postsecondary field of study—from occupationally oriented programs through traditional liberal arts—more than a ceremonial visit to college-level mathematics is called for."[4]

Collaborative efforts are necessary to achieve continuity in pre-K–12 and higher education mathematics curricula and instructional strategies. In particular, pre-K–12 and higher education mathematics faculty need to collaborate on the content of mathematics placement tests. Student mathematics outcomes should be aligned across institutions so tests are fair, reasonable, and reflect agreed upon outcomes. Many students in

high school experience mathematics in context, using technology. A majority of high school exit examinations allow the use of graphing calculators.[5] In contrast, some higher education mathematics placement exams test only basic arithmetic and algebraic computation without technology. These differences in the use of technology also need to be addressed. Collaborative efforts to implement standards-based mathematics can be an initial step in minimizing the need for remediation in postsecondary mathematics education, address the critical need for students to complete algebra, and help to ease the transition from high school to college.[6]

Providing in-depth professional development for pre-K–12 mathematics teachers to implement mathematics standards for school mathematics has become a priority in many schools. The need is particularly great in the middle grades, where a high percentage of teachers have mathematics preparation that focused mainly on computational arithmetic. These same teachers, with minimal training, are expected to lay the foundations of algebra, teach basic geometry and measurement concepts, and introduce applications of probability and elementary statistics to students in the middle grades. Two-year colleges and school districts should partner, working together to help teachers better understand the mathematics content and related pedagogy that local and state standards require.

Dual enrollment programs—programs where a high school student enrolls in a postsecondary institution and may earn credit in both institutions simultaneously—promote connections between high schools and postsecondary institutions. Maintaining appropriate content and pedagogy in these programs is challenging. The high school mathematics courses may be taught on a college campus or collegiate courses may be taught in high schools. Regardless of the dual enrollment model used, mathematics faculty and institutions should agree on student outcomes in mathematics courses and programs, and develop appropriate curricula and instructional strategies that enhance the mathematical knowledge of all students.

Implementation recommendations to connect pre-K–12 schools with higher education:

- Two-year college and pre-K–12 district personnel will engage in dialogue and collaborate to develop a continuous, seamless, and coherent mathematical experience for students.
- College, university, and high school mathematics faculty will work together to assure that students are able to make the transition from high school to postsecondary education as easily as possible, aligning high school exit competencies in mathematics with higher education entrance requirements and content on mathematics placement tests.
- Two-year college and pre-K–12 district personnel will work together to address the need for the continuing education of pre-K–12 teachers in mathematics.

Connecting with Four-Year Institutions

Open communication between two-year and four-year institutions is a prerequisite for successful transition for the large numbers of students transferring between the institutions. As a result, it is critical these institutions collaborate to build mathematics programs and develop articulation agreements that address issues including entrance and exit requirements, course content, pedagogy, the use of technology, and assessment strategies.

Articulation agreements are essential for program integrity and to decrease duplication in course content for students. Effective articulation agreements are the result of ongoing communication and consensus-building activities. Assessment strategies and instruments, exit and entrance requirements, instructional strategies such as collaborative learning, writing assignments, the use of technology, and the inclusion of authentic applications, must be agreed upon and aligned. Expectations of students and faculty must be communicated broadly and implemented at all institutions.

Two-year colleges play a vital role in the preparation of future teachers. It is critical for two-year colleges to "develop partnerships with both K–12 schools and four-year colleges and universities to design curriculum and assessments, enhance K–12 and community college student progress in science, math and technology, and maximize scarce public resources through creative use of shared technologies, classroom space, and staff expertise."[7] Two-year college mathematics faculty, for example, can learn lessons from teacher preparation programs and provide hands-on experiences in schools for future teachers.

Implementation recommendation to connect two-year colleges with four-year institutions:

- Mathematics faculty at two-year colleges and the four-year institutions will collaborate to build and enhance mathematics programs and develop articulation agreements regarding exit and entrance requirements, course content, pedagogy, the use of technology, and assessment strategies to ensure that students will experience smooth transitions from one institution to another.

Successful transfer from a community college to a four-year institution is often the only opportunity these individuals (community college transfer students) have to achieve a bachelor's degree, particularly in the case of low-income students. If articulation programs are not in place, these high-risk students often fall through the cracks and never complete their education.

Education Commission of the States, *Transfer and Articulation Policies,* February 2001, p. 1.

Connecting with Publishers and Instructional Resource Developers

The mathematical and instructional standards and strategies presented in *Beyond Crossroads* need to be communicated broadly and incorporated into instructional materials that may be in print, video, digital, or some other media or format. Incorporating the recommendations of *Beyond Crossroads* into instructional materials benefits all parties—students, faculty, and publishers. Faculty, collaborating with publishers, as both writers and users of standards-based materials, can incorporate research into practice and guide the design of textbooks and other instructional materials. Only through cooperation between faculty and publishers, will standards-based materials become the norm.

To get texts to change, faculty must tell publishers' representatives what they want and what they need.

AMATYC, *Mathematics for the Emerging Technologies,* 2003, p. 15

Implementation recommendations to connect faculty with publishers and instructional resource developers:

- Mathematics faculty, AMATYC, and its members will collaborate with publishers and other course materials developers to incorporate the principles and standards of *Beyond Crossroads* into instructional materials.
- AMATYC and its members will collaborate to create digital products to give faculty access to ideas, programs, and materials that support *Beyond Crossroads*.

Together, we must ensure that U.S. students and workers have the grounding in math and science that they need to succeed and that mathematicians, scientists and engineers do not become an endangered species.

Business Roundtable, *Tapping America's Potential: The Education for Innovation Initiative,* July 2005, p. 14.

Connecting with Business and Industry

Two-year colleges, business, and industry need to collaborate and identify the mathematical needs of the workplace in the 21st century. Employees are now expected to be quantitatively literate and possess a high level of specific mathematical skills. Higher education institutions, especially two-year colleges, play an important role in educating and training those employees.

Mathematics departments play a major role in the mathematics preparation of the workforce. In order to be responsive to workforce needs, departments should establish advisory committees including representatives from business and industry to engage in regular conversations about the mathematical expectations of prospective employers. These committees should share useful information regarding content and assessment, identify opportunities for recruiting guest speakers and adjunct faculty with unique qualifications, and ways to understand the language and culture of education and business.

Business and industry partnerships must provide opportunities for offering specialized mathematics courses and programs for the workforce and aligning these courses and programs with employee expectations. Institutions need to find ways to implement methods for tracking their students after enrollment or graduation to determine whether or not mathematics courses and programs meet students' educational or career needs.[8]

Implementation recommendations to connect education with business and industry:

- Mathematics faculty will establish relationships with business and industry to gather information about workforce needs and to incorporate relevant content and application into their courses.
- Two-year colleges will work with other institutions of higher education to collect information to determine whether or not mathematics courses and programs have met students' career needs and whether they have acquired the necessary mathematics skills needed by their employers.

Connecting with Professional Societies, Government Agencies, and Policy Makers

Designing and implementing policy in mathematics education is the responsibility of all stakeholders. These policies should be determined after careful dialogue and active involvement among them. The mission and uniqueness of each entity should be respected, while putting forth a unified voice in support of standards-based mathematics education and improvement of student learning in mathematics.

All stakeholders need to continue to establish and enhance their relationships. National leaders in government, education, and on professional boards need to be informed of *Beyond Crossroads*, incorporate its principles and standards into policy, and allocate funds to promote innovation. AMATYC and its members should also stay informed about activities and documents of other stakeholders. The notable contributions in mathematics education of the National Council of Teachers of Mathematics and the Mathematical Association of America influenced this document. Garnering support from professional organizations, federal agencies, policy makers, foundations, and businesses will significantly help to further implement *Beyond Crossroads*.

America's economic preeminence, national security, and social stability are dependent on the mathematics and science abilities of its citizens.

Business–Higher Education Forum, *A Commitment to America's Future: Responding to the Crisis in Mathematics and Science Education,* January 2005, p. 32

Implementation recommendations to connect professional societies, government agencies, and policy makers with education:

- AMATYC and its members will collaborate with other boards, societies, organizations, agencies, and policy makers to disseminate *Beyond Crossroads* broadly and promote standards-based mathematics education for all students in the first two years of college.
- AMATYC and its members will actively work with government agencies, foundations, and other funding organizations to align AMATYC's programs with the mathematics community and they will partner with other professional mathematics organizations to create a unified strategy for improving mathematics education for all students:

Conclusion

Improving student learning in mathematics and implementing mathematics standards is a multifaceted endeavor. Globalization, technological advances, and dynamic mathematical expectations and requirements, create ongoing challenges for the mathematics education community. Faculty, with support from their institutions, shoulder the day-to-day responsibility for continuing to grow in their mathematical and pedagogical knowledge, contributing to their profession, addressing the learning needs of their students, and preparing quantitatively literate citizens for the future. But, faculty and institutions cannot accomplish their goals alone. The collection of individuals and institutions dedicated to improving mathematics instruction will become a community working towards systemic change when every stakeholder collaborates to achieve the following:

Change is good…you go first.

Bumper sticker

- build public understanding and support
- make connections with pre-K–12 school districts and higher education institutions
- develop standards-based instructional resources
- establish an ongoing dialogue with business and industry
- speak with a unified voice in support of the improvement of mathematics education for all.

Implementing standards is not easy. Improving student learning in mathematics cannot occur only within one isolated entity. It requires incremental and systemic changes in actions, structures, and mechanisms. These changes lead to the most effective outcome when individuals and institutions design and implement cultures, strategies, and policies collaboratively to improve student learning in mathematics. This implementation process continues to improve through reflection, assessment, redefinition of goals and objectives, and continuous improvement. Embracing change requires working together, making informed decisions, using innovative strategies, documenting results, and refining goals, objectives, and actions. If all stakeholders do not play an active role in implementation, the impact of those who do, can be greatly diminished. Everyone has a role in creating a mathematics community with its core goal of helping all students be successful learners in mathematics.

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1 Leinwand, S. & Burrill, G. (Eds). (2001) *Improving Mathematics Education: Resources for Decision Making*, Washington, DC: National Academy Press, p. 45.

2 Moses, R. (2001). *Radical Equations: Math Literacy and Civil Right*s. Boston, MA: Beacon Press, p. 5.

3 National School Boards Foundation. (2005). Education Leadership Toolkit: Change and Technology in America's Schools. A project of the National School Boards Foundation implemented by the NSBA Institute for the Transfer of Technology to Education with a grant from the National Science Foundation (REC-9603345), retrieved 3/30/2006 http://www.nsba.org/sbot/toolkit/chned.html, p. xviii.

[4] Adelman, C. (2006). *The Toolbox Revisited: Paths to Degree Completion from High School through College*. Washington, DC: U.S. Department of Education, p. 108. Retrieved 4/12/2006 from http://www.ed.gov/rschstat/research/pubs/toolboxrevisit/index.html.

[5] Eighty-one percent of the states in the U.S. require exit exams that allow calculators to be used on at least some test items. Similarly, 79% of the states without exit exams allow calculators to be used on state-mandated mathematics tests for high school students. *NCTM News Bulletin* (Sept. 2003), p. 8.

[6] Achieve, Inc. and the National Governors Association. (2005). *An Action Agenda for Improving America's High Schools: 2005 National Education Summit on High Schools*. Washington, DC: Achieve, Inc.

[7] American Association of Community Colleges (AACC). (2005). *Teaching by Choice: Community College Science and Mathematics Preparation of K–12 Teachers*. Washington, DC: Community College Press, p. 15.

[8] Discussions with Dr. Sadie Bragg, Borough of Manhattan Community College (NY) and Dr. Judy Ackerman, Montgomery College (MD) (August 2003).