Preface

Vision without action is a daydream.
Action without vision is a nightmare.
~Japanese Proverb

What is the Current Vision?

We live in a period where we are inundated with vast amounts of information critical for decision-making. Yet, many adults are often ill-equipped to make sound judgments. Mathematics, thus, is essential for developing informed citizens in the global society. In the United States and Canada, the teaching and learning of mathematics in the first two years of college plays a vital role in preparing individuals to solve problems in their personal lives, on the job, in society, as well as for specialized study in the fields of their choosing. Historically, the role of two-year colleges has included (a) providing general liberal arts education to students for associate degrees for the job market or transfer to four-year colleges, (b) vocational certification, (c) community education for lifelong learning and enrichment (Cohen & Brawer, 2008; Labaree, 1997), and (d) more recently, retraining workers to keep abreast with a changing economy (Mesa, Wladis, & Watkins, 2014).

In recognition of the importance of mathematical sciences for the common good and of the two-year college's role in mathematics education, the American Mathematical Association of Two-Year Colleges (AMATYC) published the forward-looking *Crossroads in Mathematics: Standards for Introductory College Mathematics before Calculus* (AMATYC, 1995) and redoubled its implementation via *Beyond Crossroads: Implementing Mathematics Standards in the First Two Years of College* (AMATYC, 2006). The 1995 standards were developed in the context of the calculus reform movement (Douglas, 1986; Steen, 1988) and the *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics, 1989). The *Beyond Crossroads* document was driven by a need for broad implementation of the 1995 standards, by an increased awareness of the need for adult quantitative literacy (Steen, 2001), and by educational research that indicated increased learning through student engagement and appropriate use of technology (Faust & Paulson, 1998; Hassi, Kogan, & Laursen, 2011; Hassi & Laursen, 2009, 2015; Khoshaim, 2012; Meyers & Jones, 1993).

Why the Need for a New Standards Document?

AMATYC provides leadership in the mathematics community for improving mathematics teaching and learning in the first two years of college throughout the United States and Canada. In particular, through *Crossroads in Mathematics* (AMATYC, 1995) and *Beyond Crossroads* (AMATYC, 2006), the organization has led the way to improve mathematical experiences for both students and faculty

in the first two years of college. AMATYC views the development of standards as part of its ongoing process to strengthen mathematics education. In order to maintain their viability and currency, such documents must be reviewed and refined periodically. *IMPACT: Improving Mathematical Prowess And College Teaching* builds on the thinking behind the standards of the previous documents while encouraging the exploration of new frontiers in mathematics education. The addition of IMPACT Live!, the online extension of *IMPACT*, provides a platform for continuous sharing of initiatives and best practices.

Over the past two decades, research in the mathematical sciences has increased and broadened, revealing a world increasingly dependent on mathematics. The "demand for people with strong mathematical science skills is already growing and will probably grow even more" (National Research Council [NRC], 2013, p. 16). Increasingly, professionals in a variety of fields are "presented with the challenges and opportunities of large-scale data analysis and mathematical modeling" (NRC, 2013, p. 116). In ever-growing ways, the tools of mathematics continue to be used in a multitude of fields such as building trades, medicine, military science, communication and information science, and by physical and occupational therapists, social workers, artists, architects, and graphic designers.

In response to these developments in the mathematical sciences, and in the world at large, school and collegiate mathematics have changed significantly since AMATYC published *Beyond Crossroads* in 2006. As K-12 mathematics standards have evolved to integrate the Common Core initiative (National Governors Association Center for Best Practices & Council of Chief State School Officers [NGA Center & CCSSO], 2010), a need has emerged to reevaluate the teaching and learning of mathematics in the first two years of college. The changing roles of topics such as developmental mathematics, statistics, modeling, and pathways have been reexamined through collaboration among faculty at local, state, and national levels.

At the K-12 level, in 2010 the NGA Center & CCSSO released the Common Core State Standards for Mathematics (CCSSM). This set of recommendations has influenced mathematics education in the United States. Its recommendations for K–12 mathematics education include a focus on reasoning and problem solving, increased emphasis on modeling and statistics, and a balance among concepts, procedures, and applications. Its large-scale implementation and associated assessments are influencing *what* mathematics is taught and *how* mathematics is taught. As these standards and related assessments evolve, Common Core continues to have widespread impact.

As the students progress through education structured according to the Common Core standards, it was apparent that higher education needed to change as well. Subsequently, at the collegiate level, three recent reports represent significant landmarks in the evolution of undergraduate mathematics in the United States:

- *Common Vision for Undergraduate Mathematical Sciences Programs in 2025*, edited by Saxe and Braddy (2015) and published by the Mathematical Association of America (MAA) in collaboration with AMATYC, the American Mathematical Society (AMS), the American Statistical Association (ASA), and the Society for Industrial and Applied Mathematics (SIAM)
- *GAIMME: Guidelines for Assessment and Instruction in Mathematical Modeling Education*, published jointly in 2016 by the Consortium for Mathematics and Its Applications (COMAP) and SIAM
- The *Guidelines for Assessment and Instruction in Statistics Education (GAISE) College Report 2016*, published in 2016 by the ASA. This report updates the original *GAISE College Report* (Garfield et al., 2005)

These three documents demonstrate a general recognition that "the status quo is unacceptable" (Saxe & Braddy, 2015, p. 4), that statistics and modeling deserve increased emphasis, and that new

curriculum choices are needed to meet the mathematical needs of many college students. AMATYC, AMS, ASA, MAA, and SIAM agree that this innovative mathematical curriculum needs to deemphasize lecture, to increase the use of active student-centered learning (Conference Board of the Mathematical Sciences, 2016), to make connections to other disciplines, and to engage students in written and oral communication and the meaningful use of technology. As a result, initiatives have begun in the areas of statistics and modeling, developmental mathematics, pathways, and collaboration has started between AMATYC and other organizations.

The increased need for the emphasis on statistics and modeling is actually demonstrated by the data itself. Of the 156 Common Core high school mathematics standards, 61 (nearly 40%) are standards in modeling or statistics. From 2010 to 2015, the number of students taking the AP Statistics exam rose by more than 150% to nearly 200,000 students. At U.S. colleges and universities, from fall 1990 to fall 2015, undergraduate enrollment in statistics courses more than tripled from 223,000 to 711,000 students. The increase from fall 2010 to fall 2015 alone was 41%, and of the 711,000 students enrolled in statistics, 35% were at two-year colleges (Blair et al., 2018). Moody's Mega Math (M^3) Challenge is an example of an initiative in modeling. It is an annual competition for high school students. It began with 572 students competing in 2006. In 2015, it had grown to nearly 7,000 competitors. Seeing the need to offer a similar opportunity for students in the first two years of college, AMATYC created the Student Research League in 2017. The competition entails finding a solution to an open-ended problem using mathematical modeling as well as researching careers related to the focus of the problem.

An example of an initiative in developmental education involves a collaboration between AMATYC, the National Association of Developmental Education (NADE) and the MAA. Together these groups sponsored national summits on developmental mathematics in 2013, 2016 and 2018. These summits brought together a wide range of professionals to share the latest findings in mathematics education research and development concerning students who enter college underprepared to pursue college-level mathematics.

Over the past decade, many two-year colleges have also used institutional and national data to determine that developmental students' persistence to an associate degree within eight years is consistently around 25% (Bailey, 2009). This startling statistic inspired two-year college leaders, researchers, and policymakers to explore possible solutions to improve students' outcomes to and through the first college level course (Bailey, Jaggars, & Jenkins, 2015; Hodara & Jaggars, 2014). Rethinking mathematics education in first two years of college is the current focus (Saxe & Braddy, 2015). What is it now? What should it be?

Research (Charles A. Dana Center, n.d.) related to curriculum and program development in mathematics education at the two-year college level has initiated the reexamination of courses in mathematics that align with a student's program of study. Institutions of higher education across the country are redesigning their mathematics programs to offer multiple pathways to help students achieve their intended goals.

There are currently three curriculum redesigns, referred to as pathways, which are being implemented nationally:

1. The statistics pathway is designed for students pursuing nursing, social work, and criminal justice.
2. The quantitative reasoning pathway focuses on fields such as communications, graphic design, and paralegal studies.
3. The traditional STEM pathway intended for students entering fields such as physics, chemistry, mathematics, computer science, and engineering.

Another promising development is the growing collaboration between high schools and colleges. This collaboration has included standards alignment, precollege interventions, improved placement practices, and dual enrollment, whereby students can earn college credits while still in high school. Dual enrollment has expanded from about 80,000 students in 2010 to 94,000 students in 2015, a 17.5% increase (Blair, Kirkman, & Maxwell, 2018). While school-college collaboration is not without challenges, such partnership inspires movements such as seen in *Seizing the Moment: Community Colleges Collaborating With K–12 to Improve Student Success* (American Association of Community Colleges, Association of Community College Trustees, & Higher Ed for Higher Standards, 2016), which aims to ease the transition from secondary to post-secondary education on all fronts, not just mathematics.

Transforming Post-Secondary Education in Mathematics (TPSE Math) is an expanding collaborative effort by leaders in mathematics education across the United States. Collaboration between AMATYC and TPSE Math smooths the transition from two-year to four-year colleges and research institutions. This initiative fosters work among a wide range of stakeholders that now includes community colleges "to effect constructive change in mathematics education at community colleges, four-year colleges, and research universities" (TPSE Math, 2017, para. 1).

Taken together, these developments call for a rethinking of the first two years of college mathematics: what it is now, and what it can be and should be in the future. New mathematical pathways are needed, ones that incorporate statistics, modeling, and meaningful use of technology, that deemphasize lecture, and actively engage students. This view is supported by the vision statement for TPSE Math, which W. E. "Brit" Kirwan quotes in his foreword to the Common Vision: Postsecondary mathematics should "enable any student, regardless of his or her chosen program of study, to develop the mathematical knowledge and skills necessary for productive engagement in society and in the workplace" (Saxe & Braddy, 2015, p. v; TPSE Math, 2017). The transitions between both secondary and post-secondary institutions with two-year colleges must remain smooth so that students receive a seamless, quality mathematics education.

What is the Renewed Vision?

The standards set forth in *Crossroads in Mathematics* and reinforced in *Beyond Crossroads* were visionary and remain current today. Nonetheless, there are serious challenges facing mathematics education; fortunately, they are tempered by an unprecedented spirit of collaboration across educational institutions and professional organizations. Various stakeholders are working with AMATYC to implement student-centered mathematics instruction that is both effective and efficient. Moreover, there is ample research evidence that engaging students in problem solving, reasoning, and sense making will yield improved mathematical proficiency, statistical proficiency, and quantitative literacy. By continuing to work with other stakeholders, faculty who teach mathematics in the first two years of college can develop bridges for students from their current state of mathematical understanding to a deeper level.

The vision presented in *IMPACT* is to improve mathematics education in the first two years of college by presenting clear guidance on how to impact the mathematical prowess of students. This guidance is intended to inspire faculty, departments, institutions, and policymakers to examine, assess, and take action to improve every component of mathematics education in the first two years of college. AMATYC and its membership will engage in this renewed vision to positively impact undergraduate mathematics education.

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