A Common Vision for the Undergraduate Mathematics Program in 2025[1,2,3]

Project Overview for JMM 2015

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The primary goal of this initiative is to develop a shared vision in the mathematical sciences community of the need to modernize the undergraduate mathematics program, especially the first two years.

Our premises are:

1. Mathematical scientists – including mathematicians, applied mathematicians, statisticians, computer scientists, and mathematical sciences educators – can contribute to scientific initiatives to advance national priorities that are in the best interests of all citizens.

2. The most productive approach to preparing the next generation of citizens literate in Science, Technology, Engineering, and Mathematics (STEM) will involve multidisciplinary teams of mathematicians, statisticians, computer scientists, and domain specialists from STEM and non-STEM fields, working together to modernize the undergraduate mathematics program.

3. Mathematical sciences courses in the first two years of college function as pathways into many different STEM majors and also as key components in the preparation of scientifically literate citizens.

Mathematics and education in the mathematical sciences are in the national spotlight, in part due to the role they play in economic mobility. We intend to capitalize on this attention, and change the public perception of mathematicians and the vitality of work being done in mathematical sciences education.

Impetus to change. We are responding to national calls for action to improve undergraduate training in mathematics and statistics. These calls include, but are not limited to, *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics* (President's Council of Advisors on Science and Technology, 2012) and *The Mathematical Sciences in 2025* (National Research Council, 2013).

We are also responding to the fact that the environment for learning and teaching mathematics in higher education has undergone and continues to experience significant changes. Changes are particularly profound in the areas of: student preparedness and student diversity; student career goals and the need for workplace skills; quantitative skills demanded by more disciplines including, for example, the social sciences; advances in technology; state budget cuts for post-secondary education and shifts in states' funding priorities from funding based on enrollment to funding based on completion.

Our community recognizes that many students encounter significant barriers along the traditional route to a STEM career and thus graduate with inadequate mathematical competencies as they enter the U.S. workforce. *The Mathematical Sciences in 2025* (NRC, 2013) suggests that we reassess the training of future generations of mathematical scientists in light of the increasingly cross-disciplinary nature of the STEM fields. Substantial efforts have been undertaken to help us understand the challenges; indeed, promising curricular updates and pedagogical practices have been recommended. However, few such practices are being

[1]The project leadership team includes representation from five professional associations who focus on undergraduate mathematical sciences programs as an integral part of their mission (American Mathematical Association of Two-Year Colleges (AMATYC), American Mathematical Society (AMS), American Statistical Association (ASA), Mathematical Association of America (MAA), Society of Industrial and Applied Mathematics (SIAM)): Karen Saxe (Principal Investigator, Macalester College), Linda Braddy (co-PI, MAA), John Bailer (Miami University), Rob Farinelli (College of Southern Maryland), Tara Holm (Cornell University), Vilma Mesa (University of Michigan), Uri Treisman (University of Texas at Austin and Charles A. Dana Center for Innovation in Math and Science Education), and Peter Turner (Clarkson University). Affiliations are for identification purposes only and do not imply an institution's endorsement of this document.

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implemented at a scale necessary to make a significant impact on the number of mathematics graduates entering the workforce, the number of students pursuing a degree in mathematics, or the number of graduates in all fields who have adequate mathematics skills and competencies to meet current workforce demands. Further, these efforts are often made in isolation. Facilitating multiple pathways to help students overcome barriers encountered in coursework in the mathematical sciences requires a well-coordinated effort of multiple stakeholders, including faculty, higher education administrators, employers, professional associations, and funding agencies. By bringing together thought leaders from these various sectors, *Common Vision* will ultimately serve to catalyze widespread adoption of modernized curricula and pedagogies.

Phase I: Identifying Common Themes. Phase I is intended to provide a snapshot of the current thinking about undergraduate mathematics programs, and we have thus begun with introspection. We have chosen seven curricular guides on which to focus, each of which is a major enterprise endorsed by the supporting association:

- *Beyond Crossroads*, released by AMATYC in 2006. http://beyondcrossroads.matyc.org/
- *Guidelines for Assessment and Instruction in Statistics Education College Report*, released by ASA in 2012. http://www.amstat.org/education/gaise/
- *Guidelines for Undergraduate Programs in Statistical Science*, released by ASA in 2014. http://www.amstat.org/education/curriculumguidelines.cfm
- The *Committee on the Undergraduate Program in Mathematics Curriculum Guide*, to be released by MAA in January 2015, current draft is available online. http://www2.kenyon.edu/Depts/Math/schumacherc/public_html/Professional/CUPM/2015Guide/CUPMDraft.html
- *Partner Discipline Recommendations for Introductory College Mathematics and the Implications for College Algebra*, released by MAA in 2012. http://www.maa.org/sites/default/files/pdf/CUPM/crafty/introreport.pdf
- *Modeling across the Curriculum*, released by SIAM in 2012. http://www.siam.org/reports/modeling_12.pdf
- *Undergraduate Programs in Applied Mathematics*, released by SIAM in 2014. http://www.siam.org/reports/undergraduate_14.pdf

Phase I will culminate in a two-and-a-half-day workshop for over fifty participants held in May 2015 at ASA headquarters in the Washington, DC area. Participants will represent the five mathematical sciences associations listed in the first footnote, partner STEM disciplines, and industry. A full report (fall 2015) will articulate the commonalities found in these seven curricular guides, give an account of workshop activities, and lay a foundation for Phase II projects. This report exists in draft from; we have identified common themes in the seven reports below and classified them into four interdependent categories: curricula, workforce training, pedagogies, and faculty development. We have also highlighted a number of further topics addressed in some of the guides that we view as critical for improving undergraduate mathematical sciences education. Other outputs produced thus far include a white paper to the White House Office of Science and Technology Policy.

Phase II: Moving Forward. Phase II of *Common Vision* will be an outward-looking period focused on widespread dissemination and implementation of modernized curricula and delivery methods.

Given the importance of the mathematical sciences in solving problems of national importance, we propose to establish a *Center for the Advancement of Mathematical Sciences Education* (CAMSE) to support improving teaching and learning in undergraduate mathematical sciences courses. This Center will be modeled after the NSF mathematical sciences institutes. Such a structure would help facilitate adaptation, implementation, and scaling efforts.