



Regional Meeting
University of Maryland, Baltimore County
November 15, 2014

Meeting Summary

Introduction

TPSE Math, an effort dedicated to Transforming Post-Secondary Education in Mathematics, held the first of a series of regional meetings at the University of Maryland, Baltimore County (UMBC), on November 15, 2014¹. Additional meetings are planned for the West Coast, Midwest, Southeast, and elsewhere.

The purpose was to hear from mathematicians and administrators at a variety of two-year colleges, four-year colleges, and universities about challenges to post-secondary mathematics and efforts to address these challenges. Challenges include outdated curricula, a mismatch between what is taught and what students need to know, low participation by disadvantaged students, and poor communication among institutions and STEM fields.

The first public TPSE Math meeting was held in June 2014 at the University of Texas at Austin. A summary of that meeting, as well as videos and PowerPoint presentations, provide further perspective; they are available at www.tpsemath.org/meeting1.

Discussions at UMBC were structured around three panels: (1) a description of TPSE Math and other initiatives with similar goals, (2) disparities in participation by various populations, and (3) issues facing non-R1 institutions. TPSE Math member Eric Friedlander introduced the main themes, emphasizing “how much hard work will be needed to change the culture,” partly because of its tradition of independence.

Important parts of that work have already begun, as noted by William Kirwan, chancellor of the University System of Maryland and host of the meeting. “Gone are many of our traditional lecture-recitation courses. In their place are active learning and technology-enhanced experiments.” At Frostburg State, an emporium model is credited with improving the pass rate from 60% to 80%. Towson University has reduced lecture time while improving its pass rate from 60% to 85%.

The panel that explored participation rates revealed that while issues facing minorities and women were familiar, socioeconomic status is the overriding determinant in whether students complete a bachelor’s degrees. Several speakers emphasized the value of mentoring and community building, which raise interest in mathematics and improve retention rates. Even a

¹ A meeting schedule, participant list, presentations, and videos are available at www.tpsemath.org/regional_mtg.

single committed faculty member can increase participation by conveying the advantages of a math major or minor in enhancing career opportunities.

In the panel on institutions, speakers discussed teaching innovations, such as the flipped classroom and MOOCs, but cautioned that much more evaluation is needed before new techniques are widely adopted. One participant suggested a clearinghouse for new ideas, such as interdisciplinary problem-solving.

Administration involvement is critical, agreed several speakers, in rewarding good teaching, viewing the community as interdisciplinary, and providing faculty incentives and disseminating best practices. Department chairs were described as having a primary role in building trust, involving senior faculty, and creating reform strategies.

Several participants praised a “co-requisite strategy” in which developmental students are placed simultaneously in remedial and regular entry-level credit courses. Others cited innovative entry-level courses that replace algebra or calculus with a menu of useful skills, such as quantitative reasoning, modeling, and elementary statistics.

An especially challenging issue for institutions is to make developmental courses more effective and less expensive. One inspiring program, at Towson University, showed that replacing one lecture hour by one hour in a well-staffed laboratory could improve pass rates and GPA scores while lowering costs. Freeman Hrabowski, president of UMBC and a mathematician, offered a concluding commentary. He acknowledged that “the developmental job is a big one,” as is “changing the culture on a campus.” Nonetheless, he expressed pride in the improvements already underway on his campus, affirming that “UMBC is a place where math rocks.”

Welcome

William Kirwan

Chancellor, University System of Maryland

Dr. Kirwan welcomed the participants and thanked the Sloan Foundation and Carnegie Corporation of New York for supporting the early activities of TPSE. “What’s so notable about this effort,” he said, “is that these distinguished mathematicians have had the audacity to ask some very important questions. As a mathematician myself, and a chancellor of a public university, I suggest that these are questions our mathematics community must address and answer.”

He said that at the first national convening of TPSE Math, at the University of Texas at Austin, he was impressed most by “the sense of commitment to significant change to our curriculum and teaching practice.” He also praised the level of innovation already underway, and noted TPSE Math’s plan to hold regional meetings to communicate what is being done around the country.

He said that many math departments in Maryland were innovating, including all the STEM departments at UMBC. “Gone are most of the traditional lecture-recitation courses,” he said. “In their place are active learning and technology-enhanced classroom experiences.” A “math gym,” staffed by faculty and advanced students, allows students with difficulties to stop in “for a workout.” The UM-College Park has started course meetings five times per week; the first five weeks are spent on remedial topics, and the next 10 on one of four credit-bearing topics. The pass rate for these students is 85%, he said, and they meet the university’s general math requirements in one semester. In previous times, he said, these students would have been in a remedial course all semester; many would have failed and had to start over.

Other campuses were reporting similar success. Frostburg State University had implemented an emporium model, which improved the pass rate from 60% to 80%. Towson University had reduced lecture time while increasing lab time, technology, assistance, and faculty mentoring, improving the pass rate from 60% to 85%. MJ Bishop, director of the Center for Innovation in Excellence and Learning at the University System of Maryland (USM), said that such changes had brought “some reduction in the cost of course preparation.”

Challenges, Values, Efforts

Eric Friedlander

University of Southern California; TPSE Math

Dr. Friedlander offered an overview of the “challenges, values, and efforts” pursued by the math community in general. “Here in Maryland,” he began, “things are moving in ways we would like to see all over the country,” which he said included a holistic approach and a focus on the needs of the students. These needs, he emphasized, must vary by department and institution. While local experiments in pedagogy “need to be offered to all, one size does not fit all.”

He reviewed a series of questions originally prepared for his lecture as outgoing president of the AMS in January 2014. These questions included:

- Why is TPSE Math taking action at this particular time?
- What are the main challenges behind this “wake-up call”?
- What does TPSE Math hope to do in response to these challenges?
- How can we assess the value of changes under way or proposed?

Since January, his presentation has been expanded several times. Links to the PowerPoint and video of his presentation at UMBC are on the meeting webpage, www.tpsemath.org/regional_mtgs.

Dr. Friedlander said that as the chair of a math department, he knew how much work is required to effect even modest changes, and how different student expectations are in the age of the smart phone and Google. One reason for optimism, he said, is that “all of us share many

of the same problems,” so that members of the mathematics community may be more willing to collaborate in addressing those problems. Already, he noted, voices throughout the community are discussing ways to generate new curriculum materials, improve evaluation of teaching and learning techniques, quantify economic benefits of mathematics, and incentivize faculty involvement.

Discussion

Dr. Kirwan commented that when a good idea is found to work, it is often difficult for another institution to adopt it. “This seems to be something in our nature,” he said. “We don’t want to accept something new from elsewhere.”

Dr. Friedlander agreed that the “not invented here” syndrome had deterred promising initiatives. He also described another barrier to reform observed during a calculus study by David Bressoud, who found that successful teaching was often idiosyncratic. An innovation may produce excellent outcomes in the hands of a skilled teacher, he said, but the same innovation by a mediocre teacher might actually lower that teacher’s effectiveness. “Many of us teach in our own way, and we don’t want to dictate how to teach. You can’t just take a package that works here and expect it to work there.”

Uri Treisman, of UT Austin and TPSE Math, agreed that there are few examples of people learning directly from each other. “Innovations,” he said, “are often two parts good ideas and three parts local particulars. It takes time to replicate with integrity.”

He commented also on a “counterforce” by which universities are drawn to “something that’s sexy,” such as the flipped classroom or emporium model, without data on effectiveness. If innovations are to succeed, he said, “you need trust between a chair and faculty who have discussed outcomes.” This trust, he said, depends on data that support change, which “few chairs actually have.”

William Yslas Vélez, of the University of Arizona, said that when he was first hired as an assistant professor, “there was only one thing I was supposed to do, and that was research. Now faculty are pulled in many directions.” Many would love to do good jobs in teaching, he said, but they are so busy they lack time to investigate the value of new teaching methods.

Lou Gross, of the University of Tennessee, noted that some programs, such as Project NeXT, are designed to help junior faculty become aware of successful teaching experiments. He said that in biology, the Vision of Change project, of which he was a coauthor, offered recommendations for follow-ons that allowed teachers to use and amplify their own innovations. He also praised Project Kaleidoscope, which grew out of active learning practices, developing rubrics to help junior faculty.

Nancy Shapiro, of UMBC, said that Maryland has been “rethinking the roles of faculty,” trying to view the community as interdisciplinary and reward teaching at tenure review. The university system, through its Center for Innovation in Excellence and Learning, is highlighting such ideas to provide incentives, disseminate best practices, and inform the next generation of teachers.

Dr. Gross noted the value not just of teaching centers, but also of math tutorial centers, whose goal is to raise “quantitative literacy” among faculty and encourage them to incorporate quantitative ideas in their own courses. He noted that such centers are scarce, and that one – at the University of Nevada at Reno – had disappeared during the recession.

Panel 1: Initiatives to Transform Post-Secondary Education in Mathematics

Joan Leitzel

Ohio State University, emeritus

Dr. Leitzel, who was a professor of mathematics at Ohio State University for 25 years and subsequently provost at the University of Nebraska and president of the University of New Hampshire, summarized her recent experience helping to guide state-level reforms in Ohio.

She described compelling reasons for reforms, including the need to build quantitative habits of mind for students. At the same time, she said, as the number of mathematics-dependent fields increases, the study of mathematics must provide the tools students need for the study of other academic fields. In addition, technology brings new ways to deliver instruction and to design instructional materials. Regrettably, mathematics departments have been viewed for many years as “the bad guys” at a time when the nation has identified a clear need for a significantly larger mathematics-knowledgeable work force.

In fact, she said, both students’ needs and the needs of society are changing quickly. She mentioned several new teaching strategies, including a “co-requisite strategy” which places developmental students in regular entry-level credit courses as well as co-requisite support courses. She also noted experiments with innovative entry-level courses that replace a traditional college algebra course with a menu of quantitative reasoning, modeling, and elementary statistics, “skills many students will need.” Beyond entry level, more students are offered multiple pathways, research experiences, and internships.

Needed on each campus, she said, are networks linking math faculty with other STEM faculty, engagement of stakeholder populations, and collaboration across different kinds of institutions.

She also emphasized the need for assessment tools to measure the effects of changes. “We can’t simply trust our instincts,” she said. “We require some comparable data across institutions, with different instruments measuring the same things.” Fortunately, she said, no department needs to “start at the starting line or run this race alone.” Promising work is underway in many places.

The project in Ohio involves all 36 of the two- and four-year public institutions, brought together by the state's higher education coordinating board. One issue is the transfer of mathematics course credits for students who transfer from one institution to another, in particular from two-year to four-year institutions. A second is that the state's adoption of Common Core Standards forces postsecondary departments to rethink entry-level courses. To approach these issues, the board formed a higher education steering committee composed of five faculty members from community colleges, six from universities, and Dr. Leitzel as the "neutral chair."

With Uri Treisman serving as external consultant, the committee identified five areas where change was likely needed and identified apparent drivers of the problems identified. Their final report, finished in early 2014, stated that implementation would need to be done on the campuses "by faculty who understood these matters, and not handed down from on high." The 36 departmental chairpersons then took the lead in this work. They have now formed five working groups: (1) entry level courses and alternative pathways, (2) criteria and processes for course transfer, (3) strengthening communication and outreach, (4) data collection, analysis and sharing, and (5) improving the alignment of secondary and post-secondary course content and instruction. The five working groups are made up of 71 mathematics faculty, 25 of whom are departmental chairpersons. The others are faculty members with direct responsibility for undergraduate programs in their departments.

"The process shows promise," she concluded. "But the kind of changes we're discussing will require more than local and statewide initiatives." She mentioned the need for professional societies to assist in scaling up promising outcomes, for foundations and funding agencies to make some funding available, and for TPSE to be "persistent, impatient, and demanding until real progress is apparent across the country".

Matthew Ando

University of Illinois at Urbana-Champaign

Dr. Ando, who became math chair at Illinois in 2011, said that 80 to 85% of the 7,000+ undergraduates take a math course before they graduate, and 40% take one every year.

During the financial crisis, the college of engineering increased its enrollment from 5,000 to 7,400 in seven years. "Suddenly all the math courses were full," he said. "That meant our enrollment, where a large part of our job is to teach engineering students, was up 50% in linear algebra; multivariable calculus was up 25%."

To meet this challenge, the department chose to innovate. It found that many engineering students were frustrated at failing the multivariable calculus course after doing well on earlier math exams in the engineering department. By the standards of the math department, these students had been poorly prepared. Dr. Ando and his colleagues decided to "disrupt" the

process by teaching engineers the calculus series in one year, and collaborating with the engineering faculty on a new curricular model.

“The mathematics faculty still gave the lectures,” he said. “But in discussion sections, engineers and mathematicians collaborated on active learning worksheets based on engineering applications. This was very hard work; we got very angry at each other. But now, every week, students work in groups of three or four on the engineering application worksheets.”

“This has had a wonderful effect on calculus instruction in my whole department,” he said. “After we taught it, no one wanted to go back to what we had done before, and it has spread to other courses.”

Another initiative, on linear algebra, came out of working with engineers to identify what they wanted. This led to a very different course that emphasizes very large matrices and significant computing. Another course, in biocalculus, was designed by a collaboration of mathematicians, biologists, and statisticians, and others are being tested. “Interdisciplinary research is hard,” he said. “Built-up habits are hard to break down. So it is important to provide incentives.”

Dr. Ando also discussed undergraduate research and careers, noting that the number of PhD students in mathematics had doubled in the last 10 years, while the number of academic jobs has not. “It’s important to help them prepare for careers they’re actually going to have,” he said. “And that’s a lot of fun. We have a development advisory board of wealthy alums. We get them involved in conversations about the department. They push us in directions we didn’t think about, like helping students plan for careers. It’s magical.”

Howard Gobstein

Association of Public and Land-Grant Universities (APLU)

Howard Gobstein of APLU suggested that the reason calculus “is still such a barrier” is not that “we don’t know how to teach it,” but that we don’t know how to disseminate effective strategies, given faculty workloads and incentives. “It’s the system,” he said.

He further suggested that “there is no one right way” to improve teaching at the undergraduate level. It will require the commitment of presidents and chancellors and, because presidents and chancellors seldom teach, the actions of faculty.

He praised the Statway and Quantway designs supported by Carnegie Foundation for the Advancement of Teaching. A positive feature, he said, is that they are driven by networks and collaboration, not single faculty members. “Not even institutions can do this by themselves.” Another is their emphasis on evaluation. “You can’t improve at scale what you can’t measure. This is something we in education don’t fully recognize.”

APLU had adapted this model, he said, in a research partnership of five universities that promote active learning of introductory math. They share an “action and change agenda with

common measures,” he said, and support sustained improvement, “not just academic papers.” Action was propelled by “incredibly dedicated faculty,” who collaborate and share their progress.

The challenge, he said, was to support this type of collaboration across institutions and at greater scale. He suggested that TPSE Math might play a role. He also suggested the idea of 20 or 30 universities working together on introductory math. “Think of the visibility that would have,” he said, recommending approaches discussed on the AAU website.

To link local reforms to larger efforts he suggested a larger role for the mathematics associations, such as collecting data and raising the visibility of these issues. “Then they can take these islands of excellence, make them peninsulas, and then mainland.”

Discussion

Dr. Gross, referring to the math-engineering and math-biology collaborations at Illinois, asked how math might be incorporated in other parts of the curriculum. Dr. Ando said that new initiatives are propagating, but that each step takes time and hard work. He emphasized that successful initiatives were always generated by faculty, not deans or administrators. He added the suggestion that faculty on sabbatical, who are usually required not to teach, could in fact learn valuable practices, such as those implemented at the University of Michigan, if they were encouraged to teach.

Dr. Treisman said that interdisciplinary initiatives have usually depended on a small number of people, and tend to disappear when those people are no longer involved. “How can you sustain it?” he asked. “What makes it stable and resistant to faculty changes?” Dr. Ando said that the early efforts at reform, just over a decade ago, had poor results. Then they moved to a collaborative approach. “As chair, if I were to dump something on faculty, they would resist. Instead I started walking in with, ‘What if we tried this?’ Then they were interested.”

Dr. Leitzel cited the need for sound evaluations of new teaching techniques, such as the flipped classroom. “How does mathematics reform relate to similar efforts in other courses?” she asked. “We need to follow students and measure student persistence in the study of mathematics.”

Dr. Kirwan cited one study by the University of Maryland showing that people who came to study math were the most likely to leave the major – but the most likely to graduate from college. Dr. Shapiro added that they were also the most likely to go into teaching.

Sean Brooks of Coppin State University advised against “jumping the gun” in replacing algebra or calculus with new techniques. “It’s still worth learning to tie your shoes,” he said. He also noted the importance of sending skilled “disciples” to train others in using new techniques.

Finally, he suggested a clearinghouse for new ideas, such as joint worksheets, “which are hard work.”

Dr. Treisman followed these suggestions by urging development of tools to measure outcomes that are accurate and can be aggregated across fields. Also, he urged more study of “islands of wonderfulness” to identify common features, such as the work of the chair who builds trust and networks.

Phillip Griffiths, of the Institute for Advanced Study and TPSE Math, asked what problems the University of Maryland had had to overcome. Dr. Kirwan said that the objective was to make lower-division education, primarily in STEM courses, more effective. Each president was asked to find one person to suggest a way, to report it to the board of regents, and to measure the results. Nancy Shapiro, who was directly involved, said she went to every campus and picked the course with the worst pass and dropout rates as the test case. “The challenge was to keep senior faculty involved,” she said. “We required ownership by the department.”

Panel 2: Broadening Participation

Tara Holm, Panel Chair
Cornell University

Dr. Holm said that a question pervading all the TPSE Math discussions is that of participation and access to higher education. She said that while low participation by women and minorities was a concern, socioeconomic status was the overriding determinant. Students from the lowest quartile of income have only about a 6% chance of finishing college, while those from underrepresented race or ethnic groups have about a 17% chance.

Alycia Marshall
Anne Arundel Community College

Dr. Alycia Marshall, mathematics chair at Anne Arundel Community College, spoke about her own experience, beginning with primary and secondary years when she was bused to mostly white public schools with gifted-and-talented programs outside her neighborhood in Prince Georges County, Maryland. Hard work and natural talent led her to earn a BS in math at UMBC as a merit scholar. Although she was not a Meyerhoff, she benefited significantly from being in close proximity to the scholars. Through the vision and support of UMBC President Dr. Freeman Hrabowski, the Meyerhoff Scholars program targeted minority students and offered support, healthy competition, and study groups. The program helped to create a supportive community of learners and positively impacted the success all STEM students. “That was the first time I didn’t have to be afraid of being a nerd, of being different.”

She went on to earn a master's at Bowie State University, and a PhD in mathematics education at the University of Maryland at College Park. There she benefited from a president's "Promise" program that offered mentoring, financial support, and a network of peers.

As chair, she said, her concern is "about increasing participation and mathematical success for underrepresented groups ." At the departmental meeting last year, she said, her colleagues were upset at the low success rates for students, especially African-American males. "Addressing this," she said, "has become a passion at our college." Three successful African American male students were invited to talk in front of the entire department about their experiences, leading to an ad hoc committee called Student Success for ALL Students. "If we can find out what's going to help them, we'll probably find out what will help many more students." One sign of success was that the department had just hired the first African-American male faculty member in over 10 years.

William Yslas Vélez
University of Arizona

Dr. Velez summarized his experience at Arizona, where he began a strong personal crusade in the late 1980s to increase minority participation. At that time, about one Hispanic math major was graduating each year, and very few Native American math majors were graduates before the 1980s, this in a state with 21 Native American reservations. He initiated a minority advising program that runs for two to three weeks each summer before the start of classes. Every day he sees one student every 20 minutes from 9 a.m. until 4 p.m. "I call it 'aggressive advising,'" he said. "If they walk in and haven't declared a major, I grab them. By 2003 we had 307 math majors; now we have 629, including 120 minority math majors, and more than 700 math minors. I insist on taking care of all of the minority math majors."

Later in the year, as new students are being accepted, he pores over enrollment data for upper-division math courses and STEM courses. "I send them emails; I keep after them; I talk with them. I never suggest they change their major, but I suggest they add mathematics. I show how a math major can help them reach their goals."

He emphasized the disconnect between math requirements and what students need to meet their career goals. Students interested in pursuing the mathematics major are often required to take the traditional courses in advanced calculus and abstract algebra. These courses may not be appropriate for students interested in engineering and the life sciences. "This discourages American students from pursuing degrees in mathematical sciences," he said. "We have to find out where they want to go and design a program of study that helps them get there."

He also recommended that departments perform a self-study by collecting disaggregated data (ethnicity, male-female, domestic-international) on their graduates. For MS and PhD recipients, employment data should also be collected. "Most faculty end up teaching the same things they studied. Departments believe they are producing researchers, and they're producing college teachers."

Aloysius (Loek) Helminck
North Carolina State University

Dr. Helminck spoke about the National Alliance for Doctoral Studies in the Mathematical Sciences, which he co-directs, and whose goal is to help place students at the graduate level most appropriate for them and to “build an extensive growing community” of mentoring and collaboration.

He said that the program addresses several problems. A common danger for underprepared students, he said, is that mentoring alone is not enough; many burn out from taking too many catch-up courses and leave after their masters. In addition, many American students are underprepared for graduate mathematics because they – especially women and minorities – delay choosing a math major until late in their undergraduate studies, lagging behind foreign students. The alliance tries to motivate these students to declare earlier, and create a community that promotes retention and excitement about mathematics.

Programs at NCSU to help late-starting students include four summer institutes and academic-year programs. Early research experiences and co-mentors from industry or national labs are emphasized. Of those in summer research institutes in 2014, those planning or in grad school increased from 22.5% before the program to 98% after it.

Key features of all the NCSU programs are the excitement of real mathematical research, a more social environment (peers share living quarters and activities), a cohort for peer support, and students not far above or below them to “inspire and aspire.” As grad students learn to be mentors, they improve their own ability as researchers by running undergrad research projects, a selling point for professorial jobs.

Before the summer programs began, retention rate at three years was 72%; the current rate is 96%. A key point, said Dr. Helminck, is that mentoring in groups is both easier and more effective than supervising individual grad students.

Discussion

Dr. Treisman asked all the panelists whether their programs were sustainable. Dr. Vélez said that because “money follows the students,” there was a lot of interest in promoting his program at Arizona.” Dr. Marshall said that the faculty were “passionate” about her program, which now “has a life of its own.” Don McClure of the AMS was in discussions about supporting the Math Alliance model (<http://mathalliance.org>) in other institutions.

Panel 3: Issues Facing Non-R1 Institutions

Uri Treisman, Panel Chair
UT-Austin

Dr. Treisman introduced the panel with several points. In dealing with diversity, he urged a focus on students' strengths and assets rather than their weaknesses. Second, he noted the need to "help students learn to navigate the boundaries of their institution's social world without compromising their identities." Third, he urged better, even personal, coordination with secondary programs. He writes thank-you notes to high school teachers of his calculus students at Texas, and even sends samples of their results on homework and exams.

He also discussed his work as a consultant to other states on undergraduate math education. "I try to help chairmen understand the sources of the tectonic shifts they feel. This is clearly a time to narrow the gap between the full practice of mathematics today and what students experience in class."

For example, he said, in the last six years, 25 states have changed from enrollment-based funding to some kind of performance-based funding. "We have a chance to get ahead of the curve, to make this ours. Otherwise, people with less interest in math will make changes for us."

He emphasized that many secondary-level math course sequences need to be reexamined. Given such imbalances throughout the system, he said, curriculum reforms must come. "About two-thirds of all students in higher ed calculus are taking the same course they took in high school. This matters because the three highest failure rate courses are in math." When state legislatures ask why American students have low graduation rates, he said, they see that math is "in the way." By current College and Career Readiness standards, only 43% of high school graduates were "college ready" in mathematics in 2013, and these had a 25% chance of failure in their first course.

Like Dr. Holm, Dr. Treisman stressed the disparity between income level and college success. Students from families in the top income quartile have an 84% chance of earning a B.S. degree by age 24, while those in the bottom quartile have an 8.2% chance.

Raouf Boules
Towson University

Dr. Boules reviewed academic transformation initiatives at Towson University, the second-largest university in Maryland, with 23,000 students. About 50% of them transfer from community colleges, and many are first-generation undergrads.

A decade ago, Towson took advantage of the University System of Maryland's decision to adopt course redesign. From 2006-2009, 10 projects were funded for three years across the system,

supported by the USM-Carnegie Course Redesign Initiative, a Lumina Foundation grant, and a state grant called Complete College America. Among 10 priorities, first was academic excellence and student success, including a focus on academic transformation including “multidimensional support to faculty.”

The math department focused on the four earliest courses, through pre-calculus. These involved nearly 2500 students, 22% of the total math courses, all taught by part-time faculty. Primary goals were to improve teaching outcomes and keep costs down. A major expense was remedial courses required by 30% of incoming freshmen. These students cost more to teach, had lower degree completion, and took 8.4 more months to complete a degree.

The department developed a “replacement model,” replacing one lecture hour by one hour in a computer lab staffed by instructors and TAs. Emphasis changed from “learning by watching” to “learning by doing” and a “master learning environment” with on-demand guidance and immediate feedback. Maximum class size was raised from 30 to 40. Expertise was built up through a course redesign task force, course coordinators, technology training sessions, and faculty rewards.

Despite some roadblocks, including resistance to change by adjuncts accustomed to traditional teaching, results have been positive. Pass rates improved 10-15% in all redesigned courses, average GPA improved from 2.6 to 3.05 in the basic mathematics course, both faculty and students gave positive feedback, and costs dropped 20-30%.

Dr. Boules is optimistic about sustaining the model. Course redesign has reached a “critical degree of consistency,” he said, and become part of the departmental fabric. A committed team of faculty forms a strong base. The initiative is complemented by “stretch/accelerated” courses that allow both a remedial and a college-level course in one semester, and an experimental flipped classroom using MOOCs for pre-calculus.

Bill LaCourse

University of Maryland, Baltimore County

Dr. LaCourse, dean of the Chemistry Department, has been at the center of UMBC reform efforts since 2006, and said that the achievements of the chemistry faculty have been among the best. “Performance increases in chemistry,” he said, “have been stunningly dramatic.”

He credited Dr. Kirwan and Dr. Bishop as “catalysts” for reform, noting how difficult it is. “We all resist change,” he said. “But at Maryland we’re succeeding in changing the culture. We are taking responsibility for being the agents of change.”

In the case of chemistry, he said, transfer students were not doing as well as four-year students, so “we had to upgrade our teaching.”

The differences in achievement, he said, were caused largely by misalignments between what the incoming transfers had learned and what they needed to know for successful work at UMBC. In the case of Calculus 1, he said, a “deep-dive inventory” revealed some 50 differences between the two groups of students. The Maryland system secured grants from the NSF and others to identify the causes of these differences, which led to the diagnostic phase of the reform and the current “culture of innovation.”

Uri Treisman

University of Texas at Austin

Dr. Treisman reviewed several aspects of reform underway in Texas. One is the New Mathways Project, which began with the realization that the university’s demographics had changed radically. “We realized that 30 years ago most students started as freshmen, with few transfers. Last fall 62% of our students had transferred in, most of them with community college credit.”

The results were alarming. Only 4.7% of students in developmental math were passing. The legislature was proposing new measures on its own. Instead, the Dana Center worked out a 10-year agreement with the Texas Association of Community Colleges and the University of Texas at Austin to redesign the core developmental courses that lead to gateway courses.

This resulted in the New Mathways Project, defining three different pathways through mathematics and depending on students’ goals. The first, the Statistics Pathway, was for students seeking a statistics course as part of the general education requirement for nursing, social work, criminal justice, and other degrees. The second, the Quantitative Literacy Pathway, was designed for general studies for which math is a requirement, including majors in communications, graphic design, paralegal and others. The third is the STEM-Prep Pathway, for students seeking a STEM or math-intensive major.

In addition to these multiple pathways aligned with fields of study are the option to accelerate studies, the use of new strategies to help students develop skills, and teaching based on proven practices and context-sensitive improvement strategies. “These steps all require many administrative rule changes that must be implemented without destabilizing the system,” he added.

The pathways initiative is linked with a Transfer Champions Initiative that helps the 50 Texas community college districts align general education math courses to programs of study. The program confirms that the New Mathways college-level courses are transferable for college credit and can be predictably applied to identified majors. They also help communicate mathematics requirements for major programs of study at four-year institutions, and work with two-year colleges to modernize their courses so they are aligned with the needs of professional fields. Dr. Treisman and his colleagues at the Charles A. Dana Center at UT-Austin are currently providing strategic consulting for eight other states that are working to develop versions of the New Mathways Project.

“Each state needs to look at its own data, respecting the diversity of their institutions,” he said. “Each needs a mechanism for engaging the math chairs and other leaders to ensure the integrity of content without affecting quality. What’s astonishing is that most chairs have never met the people in the regents’ office. We had a system that worked for 30 years, but doesn’t work now. At the Dana Center, we are leading the way, but the job is far too big for the Dana Center alone. We need something larger to develop these policy packages.”

Closing Remarks

Freeman Hrabowski
President, UMBC

While Dr. Hrabowski, a mathematician, affirmed that “UMBC is a place where math rocks,” he acknowledged that “changing the culture on a campus is very difficult.” He said that much of the problem stems from the low public image of mathematics.

“The developmental job is a big one. From my perspective the problem is that people don’t love math, and don’t understand the significance of basic research. So we don’t get the funding they need. If even the highly prepared students don’t make it, and end up not liking it, how can we expect the general public to like it? How do we change the culture to have our best faculty seeing this as part of what they want to embrace?”

He noted the rapidly growing importance of mathematics to students planning careers in biology, and the importance of faculty who understand that. “Faculty have to be able to help students know what they can do in careers of different kinds,” he said. “This is what innovative teaching is. Kids learn geometry by learning how to build a greenhouse. It’s all in the culture of our institutions, the values, the language we use, the body language. That’s where change has to come from. We need to help faculty show students the possibilities.”

One way to convey the importance of mathematics, he said, is to explain the foundational role of mathematics to small technology companies. “And we have about 100 tech startups on this campus right now. We have to find ways to be more aggressive in talking about the opportunities in mathematics. You don’t have to be a genius to do something in math; you can be bright, work in groups, and do things that matter.”