I’m Joan Leitzel. I was a professor of mathematics at Ohio State for 25 years and moved into administration there as Associate Provost for Curriculum and Instruction. Then I was Provost at the University of Nebraska and more recently, President of the University of New Hampshire. I returned to Columbus in my retirement and for one year I interrupted my comfortable retirement to lead the restructuring of Arts and Sciences at Ohio State. I’ve been a division director at NSF; at one time I chaired the Mathematical Sciences Education Board at the NRC; more recently, I chaired the Conference Board of the Mathematical Sciences.

Most relevant to this meeting, last June I was fortunate to be part of the TPSE Math meeting in Austin, Texas. At that meeting I worked with the Curriculum Reform Working Group. Quite a bit of what I want to share with you here are ideas that came together at that meeting. Of course, we started by asking ourselves “Do we really need undergraduate curriculum reform?” “If so, why now?” I suspect you’ve asked yourselves these same questions. In Austin and elsewhere I’ve heard several answers and I believe the reasons are compelling. Here are some of them.

- One reason we teach mathematics is to build those important “habits of mind”—students’ logical reasoning, analytic and problem solving skills, a sense of the quantitative modeling and simulation that describe real world events and nature. All of us want our students to appreciate the uses of mathematics, its relevance, its structure, and its beauty. But in these areas it’s not clear we’re being as successful as we want to be or need to be. The traditional postsecondary mathematics curriculum is perceived as a barrier to entry into many fields and even as a barrier to College completion. We’re frequently cited as the “bad guys” at a time when the nation has identified a clear need for a significantly larger mathematics-knowledgeable work force.

- And we do teach mathematics to give students the tools they need in the study of other academic fields, and here we’re seeing some real changes. It’s no longer the case that engineering and the physical sciences are the mathematics-intensive fields. Of course, engineering and the physical sciences are very mathematics intensive, but some of their needs in mathematics have changed and continue to change, and these days there are other fields that are also mathematics dependent. NRC ‘s report, “The
Mathematical Sciences in 2025”, makes this very clear. New areas—for example, the biosciences, areas of the social and behavioral sciences and business, the emerging field of data science—all require the mathematical sciences now, and they present new challenges for our undergraduate programs.

- We also see that possible changes are not just about course content. Technology is giving us new ways to deliver instruction and new ways to design instructional materials. This opens exciting possibilities, but it is happening just as the economics of higher education is undergoing significant change and stress in many states. We’ll likely need to be even more creative than usual in finding ways to do new things without compromising quality and effectiveness.

- We’re anticipating changes in the mathematics preparation of new high school graduates as we see the implementation of new K-12 mathematics standards in most of our states. Changes at the secondary level require the rethinking of entry-level courses at the post-secondary level, including the rethinking of our courses in mathematics for teachers.

These are some of the reasons why this is an important time for us to focus on making needed changes, changes that are not only needed and also possible.

Now I’d like to turn our attention more specifically to what it is that probably must be done.

- The first is to develop appropriate, effective courses and design coherent pathways through courses for each of four undergraduate audiences: (a) students who will be mathematics majors, (b) students who will major in other mathematics-intensive fields, (c) students who will major in fields that are not mathematics intensive, and (d) students who are not prepared for our entry-level courses.
  - At the remedial/developmental level, we know our traditional courses are a dead end for far too many students. An alternative approach now being used in some departments is a co-requisite strategy (as opposed to “pre-requisite”). In this approach, students with identified deficiencies are placed in regular entry level, credit-bearing courses, rather than in remedial courses. At the same time that these students are enrolled in regular courses, they also take co-
requisite support courses or they’re assigned to clearly targeted support services that fill in the gaps—“just in time” remediation, some would say.

○ At the entry-level, we know the traditional college algebra course is designed to prepare students for the calculus and subsequent courses. Yet very few college algebra students intend to enroll or ever do enroll in a calculus course. There is a need for alternative entry-level courses that engage students and anticipate their possible majors. We’re now seeing some promising new entry-level courses that emphasize quantitative reasoning, modeling, and elementary statistics, and within these contexts develop the mathematical skills students will need in subsequent courses.

○ And we also want our courses above the entry-level to demonstrate ways the mathematics studied connects to students’ intended areas of study, as well as provide opportunities to learn in depth and opportunities to experience mathematics. It is hoped that departments will be able to provide multiple pathways into and through the mathematical sciences major and also provide research experiences and internships for students who will benefit.

○ And as I’ve already mentioned, it’s not simply the course content that needs attention. Technology is providing new options for delivery of instruction, new tools for student learning. Thus, in addition to content, we’re challenged to revisit delivery methods and instructional materials.

Now that’s a big load to lift, so let’s consider what kind of approaches likely will be helpful.

• One thing we’ll hope to see on each campus and at the national level will be networks that link mathematical sciences faculty with the other mathematics-intensive disciplines, networks that engage our stakeholders in the curriculum reform efforts. Also, meaningful collaboration across different kinds of post-secondary institutions—research universities, liberal arts colleges, comprehensive four-year institutions, community colleges—collaboration appears to improve everyone’s work. Then there’s the need for our departments to strengthen communication and collaboration with K-12. We need to be engaged in the work to improve K-12 mathematics,
and they need to better understand our expectations for what students should know and be able to do when they enter our courses. In summary: better communication, more sharing, improved networking.

- Another agenda item on the to-do list is the need for assessment tools to measure the effectiveness of the changes that are made. We know we need to collect, analyze, and share relevant data—we can’t simply trust our instincts. But learning from one another’s work and scaling up the best outcomes will require some comparable data, as well as mechanisms for sharing information.

- We need the very best people at our institutions to turn their talents and experience to this work. How do we engage them? We know their plates are already full. Each institution will need to give priority to this work and to ensure that faculty members involved in educational innovation are valued, respected, and rewarded at both departmental and the institutional levels. Some funding may be needed to support the faculty time required. And we’ll likely need to find ways to make professional development opportunities available to faculty, adjuncts, and graduate students.

Fortunately, today no department really needs to start at the starting line or run this race alone. Promising work is underway in many parts of the country and at the national level. My fellow panelists will share examples from their experience. I hope you will also, and the full report of the TPSE Austin meeting has a substantive list in Appendix 2 that you’ll want to review. Also we know that several professional societies are fully engaged, that funding agencies have been alerted, and that TPSE is providing the spark plug.

If I may, I’ll take my last minutes to briefly describe the model we’ve developed for approaching this work across the public institutions in Ohio. My hope is that hearing about an approach one region is taking may suggest ideas for others. There are 36 two-year and four-year public higher ed institutions in Ohio. Each has its own Board of Trustees, but there is also a coordinating board for public higher education, the Ohio Board of Regents, charged to bring the public institutions together on points of common interest and in support of the common good. Even though the Regents have no statutory authority over the institutions, the Governor appoints their Chancellor and the Regents work closely with the
legislature, so campuses do pay attention. In the spring of 2013 the mathematics faculty members who were working at the state level on transfer issues convinced Regents staff that there were some real problems in the current criteria and processes for the transfer of mathematics course credit from one institution to another—a serious matter given the number of students who now start at community colleges and want to transfer to four-year schools. A second concern at that time was that the State’s adoption of the CCSSM created a need for postsecondary education to rethink its entry level courses and the pathways that flow from these courses.

The Regents formed the Ohio Mathematics Steering Committee to study these issues and make recommendations. The Committee comprised five mathematics faculty members from community colleges and six mathematics faculty members from universities, plus me, the chairperson. We also had two valuable external consultants from the University of Texas, Uri Treisman and Jenna Cullinane. We started our work in the summer of 2013, identified five areas where we believed change was probably needed, identified the perceived problems in each of these areas, and for each problem we identified the apparent drivers of the problem. Then we drafted strategies for addressing the issues and met twice in extended sessions with the chairpersons of the 36 mathematics departments to get their input into our work. By early 2014 we had crafted our recommendations and written our final report. A key recognition of the Steering Committee was that the work of implementation would need to be done on the campuses by faculty who understood these matters, and not handed down from on high. The 36 department chairpersons took the lead in this work, and it looks to me like that the process is moving ahead well.

Luis Casian, chair at Ohio State, has served as convener—the chair of the chairs, so to speak. They have now formed five working groups. The first group is working on entry level courses and alternative pathways. The second is focused on criteria and processes for course transfer. The third is directed toward strengthening communication and outreach, both across the 36 mathematics departments and also on each campus between the mathematical sciences departments and the stakeholder departments. The fourth working group is targeting the need for data collection, analysis, and sharing. The fifth targets improving the alignment of secondary and postsecondary course content and instruction. The five working groups are comprised of 71 mathematics faculty
members, 25 of whom are chairpersons. The others are faculty members with
direct responsibility for undergraduate programs in their departments. Staff
members at the Board of Regents have been assigned to support the work of the
working groups, and they have obtained two small grants. It’s too soon to predict
what the outcomes will be, but I believe the process shows promise. I’d say,
“They’re off to a good start”.

As an “objective” observer now, it appears to me that the model of starting with a
study group and then challenging department chairs to take the lead makes
sense. I’m also seeing real value in linking 2-year and 4-year institutions in this
work. A frequent comment I heard as I worked with the Steering Committee was
“Oh, I didn’t know that. That’s interesting.” But I should note, there seems to be
a clear recognition that different institutions have different missions so program
uniformity is not the goal, but rather appropriate and improved programs in every
school.

Finally, as I’ve said before, there’s recognition that the kinds of changes we’re
talking about here will require more than local and statewide initiatives. We look
to our professional societies for leadership to provide curriculum frameworks,
mechanisms for sharing what is developed, mechanisms for scaling up the best
outcomes; and hopefully also professional development opportunities to
familiarize faculty and adjuncts with what’s underway inside and outside
academe. We may look to foundations and agencies for external funding if
needed to collect and share relevant data, and to evaluate the effectiveness of
new content and new approaches. And we will continue to depend on TPSE to
be persistent, impatient, and demanding until real progress is apparent across the
country.

(Never done; mathematics is a dynamic field.)