

**Transforming Post-Secondary Education in Mathematics:
Meeting of Mathematics Advisory Group**

MAG BREAKOUT TOPICS: SUMMARY POINTS

One Washington Circle Hotel
Washington, DC
March 26, 2016

Each breakout topic was discussed in two separate sessions by different groups. Discussions were recorded by volunteer scribes, and summarized here to give the flavor of the points made and questions raised. Because the topics and approaches varied (e.g., some groups offered more questions than answers), the structure of the summaries varies as well.

1. National Demand for Better Quantitative Skills / Multiple pathways (lower division)

Premise: Math is the main academic barrier to college completion – perhaps for science and engineering students as well as non-STEM. Students should get the math they need for their chosen field of study.

Main challenges:

- Need for “rigor” and what that means (not necessarily college algebra)
- Transferability and sustainability of innovations (not just courses) across institutions and states, so that faculty and advisors are confident it’s not just a fad
- Need for data on who takes what courses and how they do (in gateway math and beyond)
- Lack of equity in opportunity – pathways must not become a racial tracking system
- Insufficient teaching capacity and challenges of implementing new pathways – hiring, training, assigning teaching staff (including adjuncts); revising the departmental business model
- Policies and procedures, like placement and advising
- Outside pressures, like accreditation requirements
- Advising and other external pressures to teach/take certain content

What’s needed:

- Data collection and appropriate data access
- Faculty agency and leadership, supported by administrative participation
- Commitment and collaboration of math societies, university/college associations, TPSE Math, the Dana Center, existing and new state math task forces

Ongoing difficulty:

- An enormous amount of innovation is happening, and some essential transformation. But a lot of local innovation does not scale easily, and goes away when people leading the change disappear.

2. Building Partnerships with Other Disciplines (upper division)

Summary question: What resources and partnerships would be most useful to chairs in building partnerships with other disciplines?

Summary answer: Chairs want the support of deans and provosts, and a community of faculty willing to do the hard work of changing the culture. While changing the culture requires the hard work of communicating and collaborating, it can be done without great expense.

Questions to be answered:

- How can I encourage colleagues to collaborate in changing education?
- Are there good templates to use so we don't have to start the conversation from zero?
- National studies suggest certain approaches – are they true in your context?
- What might an upper division pathway for non-math majors look like?
- A listening campaign: What do other disciplines want when their students take our courses?
- How can I get the understanding of the other discipline required for building an interdisciplinary partnership?
- How and when are co-teaching and co-designing effective?
- Should an interdisciplinary “course” be the unit, or the module, or something else?
- How can math faculty help co-teach a module under traditional economic models?
- At Urbana-Champaign, calc for engineers, taught by mathematicians, is tied to work sheets linked to what engineers do. Can this be done elsewhere? What will it take?
- How to approach departments that don't know what math they want (and vice-versa)?
- How to get involved with individual faculty members and figure out what techniques have actually been used?
- How to make courses for students who don't have standard math preparation?
- How can isolated departments become aware of what they need to know?

These are some of the groups' suggestions:

- Respect the intellectual depth in how math is used in other disciplines.
- Teach in conjunction with faculty in a partner field who understands how the mathematical knowledge will be used.
- Without undue effort or expense, community college and entry-level courses can do a better job of illustrating the uses and excitement of math.
- Create an ongoing “provosts' academy” (or similar) to discuss course redesign, pedagogy, pathways, “clustering” math by degree program, mediation between competing deans, etc.
- Each university needs to reexamine its business model to meet these needs.
- Joint programs may benefit from bottom-up origins, lots of conversation, and top-down help.
- Spend more time talking to students about what they will need two years out – in terms of not only connections with other departments, but also in industry and government.
- Help prepare faculty to seek out industrial research problems they and their students can work on.
- People in other fields don't always know what mathematics they want, or even what the power of math is, so some selling needs to be done to help them understand.

3. Sharing Success in Leading Educational Transformation

Central questions: What incentives can chairs use to encourage colleagues toward educational reforms? What resources do chairs need to do this?

As with Topic 2 above, much can be done to change the culture through highlighting examples of success, and this may not require increased spending.

This topic is summarized in terms of Incentives and Resources.

Incentives

- Systematically highlight successes in teaching innovation within departments and at the university level.
- Provide travel grants for faculty to participate in conferences and workshops devoted to teaching and learning.
- Provide sabbatical leave for faculty who wish to explore innovations in teaching and learning (may be most practical for full professors).
- Offer summer grants to faculty to develop new teaching practices, classroom innovations, and courses.
- Highlight teaching evaluations in faculty reward structure.

Resources

- Create curated national repository of curricular/teaching innovations coupled with face-to-face workshops (include both successes and failures).
- Hold workshops for chairs on "change management" related to TPSE agenda.
- Identify compelling senior faculty who have "seen the light" and make them available for speaking engagements.
- Develop repository of data-informed examples of successful innovations.
- Work with the MAA to expand its Project NeXT.
- Establish departmental seminars on effective teaching practices.
- Employ data analytics to improve retention and student success.
- Ensure teaching effectiveness and curriculum relevance is considered in departmental reviews.
- Ensure adjuncts participate in instructional improvement programs.
- Organize forums to promote regional cooperation and collaboration among math departments.
- Create fund to support mentoring or training of faculty who want to become more engaged in teaching and learning issues.
- The best resources are people – e.g., the Maryland statewide math group, composed of the chairs of every public two- and four-year institution. Formation of this group was triggered by transfer issues.
- Consider continuing ed for faculty a "maintenance issue," funded by a 5%/year set-aside. Use it or lose it!

4. Evolving Culture of Teaching and Learning

Question: What would be most useful for chairs seeking to improve the culture of teaching and learning?

Answer: Conversations, involving heterogeneous and homogeneous groups of leaders

Recommendations

- Promote cooperative learning, e.g., through the use of “near peers.”
- Provide more professional development for adjuncts, graduate assistants, including summers and sabbaticals on teaching skills and technologies.
- Keep class size small for developmental courses.
- Make departments a “no-criticism zone,” where faculty, TAs, tutors do not criticize student work in a public setting.
- Promote HE/K-12 collaborations → shared learning.
- Use the “10-minute talk test,” delivering a simple, clear message.
- Identify a small number of high-impact practices.
- Motivate faculty through the use of data and results.
- Make innovation safe for faculty (through incentives, agreements....).
- Address poor instructional practices (going beyond pedagogy).
- Include K-12 models, provide coaching.
- Work toward strongly coordinated courses developed by faculty, sharing resources, building community.
- Connect to scholarly activities: publishing, presenting research and sharing practices.
- Highlight math ed research on undergrad teaching.
- Integrate math ed into the math department; seen as *very* challenging in some institutions.

What can TPSE do?

- Communicate these recommendations to chairs.
- Reinforce them in partnerships with math professional associations.
- Convene workshops for chairs, including cross-sector and interactive exercises.
- Work with chairs to establish standards, expectations, and effective practices for course coordinators.
- Make use of “Chair +1” teams at meetings (a chair accompanied by a faculty or administration member).
- Clarify the role of stats in reform.
- Before convening the chairs, define what we’re doing and why.
- Emphasize small, intimate groups and establish a feeling of community.
- Provide “TPSE Tip Sheets” for departments and others.

5. Broadening Graduate Training

“We have a have a good understanding of how to train ourselves, but need to be thinking more broadly about how to train grad students who will not become us.”

Issues

- Graduate programs are focused on producing researchers.
- However, more students will work in teaching, the private sector, consulting, or government, including national labs.
- The career preparation of graduate students does not align well with the diverse opportunities available to STEM graduates.

Suggestions

- Students can benefit from more “outside” experiences earlier in training, including career counseling, summer jobs, internships, work on teams, and development of “soft skills.”
- Make students aware of opportunities (ASEE grants, Navy and Air Force labs, actuarial exams, medical schools).
- Adapting training for this breadth of careers requires heterogeneous discussions among different subsets of department leaders.

Alternative pathways for graduate training

- Many students postpone career decisions until the 4th or 5th year.
- Need to discuss career issues and develop early courses for these students.
- Bring back alums to discuss careers.
- Include coursework in related fields, such as computing, stats, decision making, game theory.
- *Internships* are one very effective mechanism for graduate students to gain experience in a non-academic environment.
 - Difficulties: During years 1 and 2, prelim schedules tend to preclude internships; during later years many advisors deny internship opportunities and summer jobs.
 - Beneficial to spend one summer in an industry internship, then report back to department; internal dynamic often helps change the culture.
- Development of *soft skills* is important for work in industry and other non-academic environments. These include learning how to make effective oral presentations (quite different from giving a math talk), how to work in teams, how to understand one’s role in the overall objectives of an enterprise.
- The mathematical *skills needed in industry* generally differ from those expected in a traditional academic research career. For example, the assumptions that go into a model are perhaps more important than the analytics required to implement the model. Other examples include how to create a timeline for problem solving and how to adjust from providing a “very good” answer (useful to industry) as opposed to the “right” answer (the custom of mathematicians).
- Publicize and develop professional masters or MS/PhD programs, some with links to employers; gather more data on success of these programs.

Preparation for Teaching

- Few graduate students have enough practice in teaching; most postdocs have never run a class.
- Training should include some of how mathematics is used outside of the discipline.
- The teacher should be able to convey with some depth an answer to the students' question: What is the use of the mathematics I am learning?
- Potential teachers of mathematics should have both exposure to and practice in the use of various alternative learning methodologies, beyond the traditional lecture-homework-exam model.
- Emphasize informal discussions (e.g., five-person networks), discussion groups, community building, presentations with critiques, faculty visits to classrooms (with written feedback), TA training with writing exercises and visits.
- Encourage institutions to implement stronger incentives for good teaching.
- Implement masters for teaching, summer workshops, courses in teaching/training.
- Teaching workshops with groupings based on interests, types of institution, facilitation, gender/diversity in classroom, sensitivity issues, classroom dynamics, measures to broaden participation.

Challenge for TPSE

- Support research on best practices in preparing graduate students for rewarding and productive careers.