CBMS-TPSE Research Advisory Group

Meeting Summary

August 26, 2017

As David Bressoud posted recently on the TPSE website, the new CBMS-TPSE Research Advisory Group held its first full meeting in Washington, DC at the MAA Carriage House on Saturday, August 26, 2017.

CBMS

David introduced the discussion with a brief summary of CBMS, which he called a "shoe-string operation," with an office donated by Macalester University and two quarter-time staff members (David, Kelly Chapman). Its purpose is to coordinate the efforts of the professional societies in the mathematical sciences, running research conferences in mathematics and statistics, collecting data from mathematics and statistics departments every five years, and running special joint projects. In the interest of coordination, it works with the Common Data Committee, supported jointly by several societies, which primarily addresses data questions asked of professors.

Research Advisory Group (RAG)

The over-arching theme of the meeting was "We don't know much about what graduates do." This applies to bachelor's and PhD graduates, and more specifically, the need to know the trajectories of their careers and the practices that best prepare them for their work.

In an effort to get this information, last December the presidents of the societies agreed to set up a Research Advisory Group (RAG) to inform the policy decisions that affect mathematics education by providing a locus for the identification, consolidation, and dissemination of the relevant data, measurement tools, and research that exist and to identify the gaps that need to be filled. Its steering committee consists of Danny Goroff, Brit Kirwan, Rachel Levy, Michael McPherson, Uri Treisman, and David Bressoud.

"Maybe the data is there; we just don't have it," observed Uri Treisman in introductory remarks on the problem of understanding student trajectories. "We have a lot of questions about how math is used in business, industry, and government. Mostly we have lagging indicators that are five or 10 years old. What we need is current information to support hypothesis generation, identify the problem spaces, and build on what exists in all the professional societies."

These questions have already prompted action at the lower division level, where the use of multiple pathways (quantitative reasoning, statistics, calculus) is now widespread. In addition, classrooms are also modifying developmental mathematics by combining a college-level course with remedial coursework and mentoring.

The challenges for upper division pathways (UDPs) include development of several kinds of new pathways, including those that are interdisciplinary and/or more closely aligned with the needs of business, industry, or government (BIG). The goals of the RAG include ways to gather and analyze data about graduates that is more timely; strengthen the tools used to learn what graduates do; identify ways to better align curricula with the needs of the workplace; engage more people in projects that are more interactive than a webinar; and determine the information needs that support the generation of hypotheses about math education.

Purpose of the RAG-TPSE meeting

Among the purposes of the first RAG-TPSE meeting were the following:

- Identify a small set of specific questions which are researchable
- Identify kinds of methods that might be employed to work toward answers to specific questions
- Determine who will work on addressing these questions
- Determine which groups or societies are willing to work together.

Problems (or barriers to understanding these issues?)

The difficulties of gathering data and performing research to answer these needs were discussed at length. They include:

1. General lack of data about trajectories, success/failure, demand
    a. More specifically, the lack of data that has been analyzed and is accessible
    b. Shortcomings with content level, teaching effectiveness, students' sense of belonging, transition points, certification issues
2. The large disconnect between math that is taught in the classroom and math that is used in the workplace
3. The disconnect between what mathematicians work on in committees and what people need in the field need
4. General lack of knowledge about reform issues: what is an entry course, what is a pathway, how can we facilitate cross-institution collaboration
5. Mathematics faculty are generally not in the habit of using data to make decisions
6. We don't know which sampling populations to use
7. The math community has few supports for math education research
    a. Departments are creating programs, certificates etc. around yesterday's jobs.
8. Faculty tend to ask questions rather than establish goals
9. The discipline needs to be perceived as more welcoming and relevant
10. Adopt a more current mode of advising to include new pathways
11. Need to address complex equity issues; e.g., those who succeed at a career fair, have the right parents get the best jobs
    a. We need to know more about what shuts people out (what are the barriers)
12. How can we reduce the pain of transition (K-12 to college, college to workplace)?

Needs for data and research

There is general agreement on the need for better data and original research on the questions discussed so far, but little agreement on what is most important to know. The following were raised and discussed:

1. Who are our math graduates?
    a. Four levels: high school, 2-year, 4-year, university
    b. Three post-secondary groups: Math majors, STEM and STEM-related majors, non-STEM majors
    c. Citizens/workers who need life skills / general quantitative knowledge
2. What kind(s) of math do they need?
    a. What should we tell them about mathematics? How do we present ourselves as a discipline?
    b. Need common quantitative knowledge for citizenship
    c. What math is needed for common tasks/numeracy
    d. What kind of math is needed to educate productive citizens or workers?
    e. People often don't recognize when they are actually using math
3. What are the most productive kinds of pathways?

    a. What are their "trajectories," how are they supported?
    b. How can we determine what kinds of pathways are most helpful for each population of math graduate?
4. What kinds of math training do employers really need?
    a. What questions should math departments ask of employers?
    b. What kind of math are employees using, and how?
    c. More than half the people who work in STEM don't have a degree in STEM; how can education best prepare them for this option?
    d. We need more understanding from labor economists about demand.
5. How can we better understand math needs in the workplace?
    a. Needs vary widely, depending on jobs
    b. Best source of data is the workers themselves
    c. Good data from alumni, but they change jobs often
    d. Need to understand cycles between users and collectors of data
6. What do math departments need to know?
    a. Department heads need to know the importance of reforms
    b. Do employers know what kind of education their hires should have?
    c. How much math do non-math teachers need to know?
    d. We need a clear statement of overall problem to drive data gathering and research
    e. Need to discern what math is associated with workplace tasks
    f. Can we use NCES longitudinal data due in 2018?
    g. Data will drive change in K-12 education
    h. What questions should math departments ask of employers to better prepare students for employment and civic life?
7. How much influence do professional associations have?
    a. Which of their surveys, instruments, publications are used substantively?
    b. What are effective supports for improvement in our community?
    c. What more information do we need for associations to be effective?
    d. Associations may have to make tradeoff decisions to increase quality.
8. What kind of data and research should we be gathering?
    a. Does current demand for data science courses emphasize correlation over causation?
    b. How should we respond to the high demand for data science courses?
        i. Is the emphasis on correlation driven by employers who are accustomed to finding data patterns that meet their purposes (i.e., increase profits)?
        ii. Should it be replaced by studies of causation?
    c. To deepen the culture of experimentation and improve the profession, ensure that departmental infrastructure opens the way to experimentation.
    d. If we're tracking best practices, need to pay attention to heterogeneity.
    e. What are good examples of successful innovations?
        i. We need to hold up exemplars of success to the broader public.
        ii. How can we convince external stakeholders the math community is worth investing in?
        iii. E.g., how can some programs provide a work-ready workforce for a new industry in two years?

What are pressing questions for which we have little or no data or research?
These questions are summarized from white-board responses by participants to a request for "most important unanswered issues":

1. What are the most important reasons some students stop taking math?
2. What the most important reasons some students succeed in math?

    a. How important are such motivational factors as belongingness, meaningfulness, competence, accountability, and autonomy?
3. How is the make-up of student populations (racial, ethnics, socioeconomic, behavioral) related to their interest in mathematics?
4. Where do math graduates go after graduation, and why?
    a. What are the common pathways for "successful" math and STEM professionals?
    b. How well do math curricula align with the math used by graduates in their work?
5. What data do faculty/departments need about where graduates go?
    a. Such data is scarce; what is required to get it?

Some solutions

These suggestions are summarized from plenary and breakout group discussions.

1. We have to analyze data and do research with same rigor that we do our professional work.
    a. Observational data is useful but not conclusive
    b. Use data to create hypotheses
    c. To prove a hypothesis, need to design an experiment, using a control group and proper methodology: not easy, but powerful
    d. Begin with a few examples of what we'd like to see so others understand goals.
    e. Persuade departments of the value of measuring what they do.
2. Enhance communication
    a. Great benefits in explaining what we do
    b. Listen to alumni, who can report on the value of their education
    c. Where does useful information come from
        i. Employers, who think they know what they want
        ii. Employees, who know what they are actually doing
        iii. From mathematicians, from whom employers should learn as well
3. Tracking best practices
    a. Emulate ongoing, practical examples
    b. Encourage departments to measure what they do
4. Support ongoing programs to gather data and conduct research on the effectiveness of UDPs
    a. Define success for UDPs; e.g., whether students choose to take a second class in the subject
5. Build an effective core of people who can influence decision makers
    a. Ask 25-30 department chairs to form cores of expertise on emerging issues in various regions
    b. Add pathway and demand issues to TA training
    c. Support a community that is prepared to drive change rather than react to it
6. Network with groups beyond the math community, especially administrations
7. industry has so much to teach us… what we can teach them?
8. Internships are popular, but not a panacea
    a. To take an internship, what must you give up?
    b. Some students think they need one to get a job.
    c. Is an internship more than a way for companies to get work for free? Do we know the actual value of internships to interns?
    d. US firms used to spend enormous amounts on training; now it's miniscule
    e. European model features apprenticeships, tenure at firms
9. One popular mechanism: continuous improvement, design thinking (Anthony Bryk)
    a. Try an alternative to calculus; e.g., a modeling course
    b. Hold focus groups, other ways to gather input from students on their lives, experiences, study habits; try flipped classroom, other techniques

c. Enhance motivational factors: belongingness, meaningfulness, competence, accountability, and autonomy
d. Build in continuous improvements, so that in 3-5 years (?) can show the legislature this kind of course is serving the people who need some math
e. Support experiments and gather evidence to show that this kind of course is serving the people
    i. One measure: how many students want to take the next course.
    ii. Another measure: can you provide a trained workforce for a new company in 2 years
f. If other institutions are willing to sign on to a protocol, it might yield evidence
g. Evidence can attract other department chairs to emulate
h. The participation of other schools brings more evidence

Conclusion

A central goal, many participants agreed, is for the mathematics community to become more collaborative, proactive, and attentive to the needs of academics and students. "There's no shortage of terrifying problems that emerge every month," concluded Uri Treisman. "You're a math chair in California and they just eliminated half the courses you're teaching. There's a disconnect between what we work with on in committees and what people in the field need."

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Participants:

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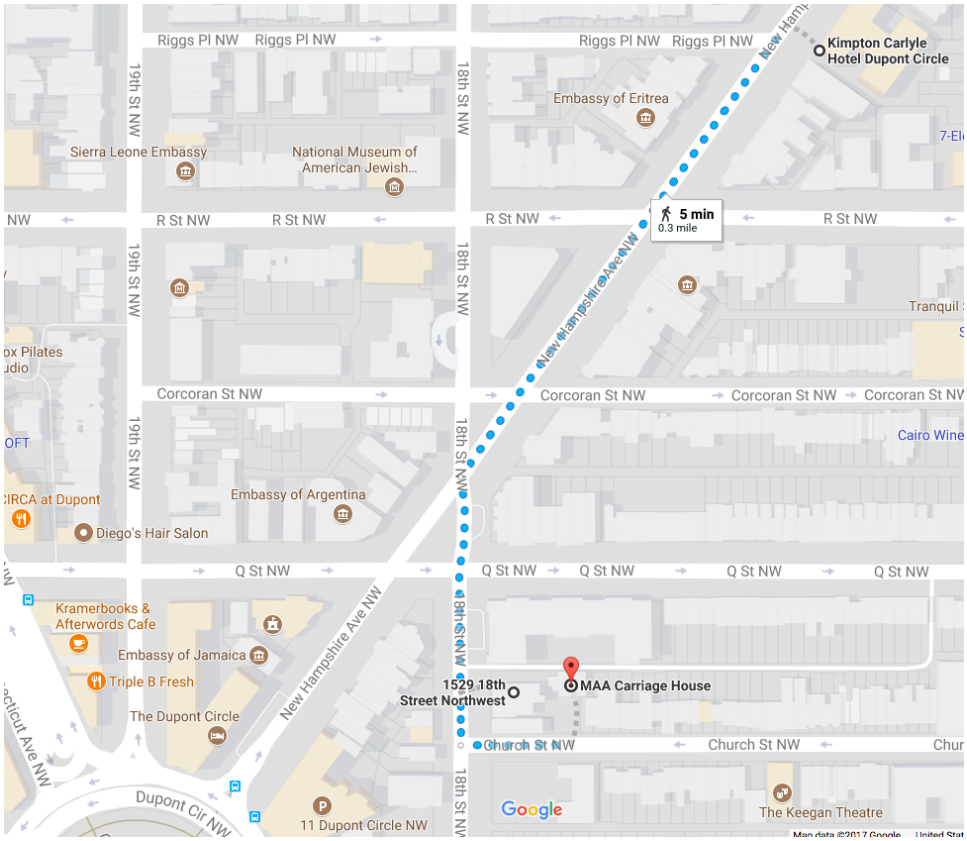
MAA Carriage House, 1781 Church St. NW, Washington, DC



MAA headquarters is at 1529 18th St. NW.
The MAA Carriage House is immediately behind the headquarters building.

What happens to our graduates and why?

This involves not just understanding their trajectories after graduation, but how the mathematics and/or statistics they have studied supports them, or what they needed from their mathematical preparation that they did not get. This question applies to at least four levels: graduation from high school, from two-year colleges, from four-year undergraduate programs, and from graduate programs. These, of course, can be broken down even finer: associate's degree versus preparation for entry into a four-year program, master's versus PhD.

I propose three goals for this meeting:

1. To identify a small set of specific questions that are researchable and for which answers would help to illuminate the big question.
2. To identify the methods that could be employed to work toward answers to these specific questions.
3. To determine what groups or societies or organizations are willing to work together on these questions.

Agenda

8:30–9:00 Coffee, tea and pastries available

9:00–9:45 Welcome; discussion of the goals for this workshop

9:45–11:15 Small groups discussions: identifying specific questions that are researchable and for which answers would help to illuminate the big question

11:15-11:30 Break

11:30-12:15 Report out, full group discussion

12:15–1:00 Lunch

1:00–1:45 Prioritization exercise: which of these questions are most pressing, most amenable to immediate action?

1:45–3:15 Small group discussions around specific questions or small sets of questions, related to the methods that could be employed to work toward answers and how groups of societies or organizations could work together to answer these questions

3:15–3:30 Break

3:30–4:30 Report out, full group discussion of action plan

4:30–5:00 Reflections and wrap-up

5:00–6:00 Reception with wine and cheese provided by Uri Treisman