

Evidence-based teaching: how do we all get there?

Issues, discussion questions, responses, ideas, and resources emerging from the Guided Discussion sponsored by the American Mathematical Society's Committee on Education at the Joint Mathematics Meetings 2019

Organizers: David Pengelley, Dev Sinha, Ravi Vakil

Find this followup document, created by David Pengelley <davidp@nmsu.edu> and Dev Sinha <dps@uoregon.edu>, and containing URL pdf links, at web.nmsu.edu/~davidp

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Introduction

We organized a 75-minute AMS guided discussion on “Evidence-based teaching: how do we all get there?” in order to stimulate the process of our community moving toward active learning in our teaching pedagogy. This is a summary report.

The event abstract stated: “Compelling reasons and resources are now in place to support shifting our pedagogy toward evidence-based active learning methods that substantially improve student success. These include the recent CBMS Statement on Active Learning, MAA Instructional Practices Guide, and MIT Electronic Mathematics Education Seminar [see Resources at end]. But implementation is not quick and easy. There are still plenty of obstacles, individual and institutional, along with opportunities. This event will foster small group discussion, and solicit ideas. Issues include graduate student and early career training; developing departmental experts who can lead and mentor; large enrollment courses; an inventory tool of teaching practices for observations and training; program evaluation and deeper, more authentic learning outcomes; programming for department chairs; redesigning the publishing of teaching materials, possibly through new economic models. Audience members should leave better prepared to implement active learning pedagogy themselves and advocate for it in their departments, connect with faculty elsewhere in doing so, and influence national efforts.”

About 70 people participated in 10 discussion groups. Discussion was based on the above givens and issues, expanded and prioritized by the participants, and on some discussion questions, and was facilitated by 15 discussion leaders. Notes were made on group discussion responses to the questions.

Here we summarize all these facets. We heartily thank our discussion leaders Beth Burroughs, Natasha Speer, Dave Kung, Jessica Deshler, Doug Mupasiri, Linda Braddy, Haley Yapple, William ‘Bus’ Jaco, Robin Gottlieb, Robin Pemantle, Chris Rasmussen, Hortensia Soto, David Bressoud, Doug Ensley, Andrew Bennett, and additionally the first seven, who provided extremely valuable notes from their discussion groups.

Issues

First participants were invited to add to the initial list of eight issues we proposed, and to prioritize these for discussions. The result was the list below, with participant numbers to the right in [] indicating their priorities (nonexclusive) for immediate discussion.

1. training graduate students and early career mathematicians: [10]
2. developing departmental experts who can lead and mentor: [10]
3. offering wide-scale programming for department chairs: [1]
4. updating inventory tools of teaching practices for observations and training: [15]
5. shifting program evaluation towards active learning and deeper, more authentic learning outcomes: [12]
6. large lectures, and the challenges they present for interaction, including individual feedback, group work, and whole-class discussion: [14]
7. dissemination of teaching materials currently biased towards lecture format: [10]
8. culture, inertia, and incentives: [15]
9. facilities: [2]
10. informed support as resource: [5]
11. finding resources: time involved: [10]
12. collaborating with peers, seeing classrooms: [16]
13. what to do to bring in colleagues?: [20]
14. leading from below, e.g., grad student or faculty member: [12]
15. learning from K-12 practices: ?

Questions, discussion, and responses

Then participants self-organized into discussion groups based loosely on high-priority issues identified above, and held sequential discussions around four broad questions, interspersed with reports and discussion with the whole group. We summarize from notes the responses to each question. Each note also indicates, via labels such as (4,5,8), which issues in the list above it matches.

- **Question 1.**

What would you most like to see happen soon in your department and institution toward widespread adoption of active learning pedagogy?

- (4,5,8) I would like to see a shift in the institutional culture from one in which the traditional lecture method is accepted as the default/standard method of instruction to one in which active learning methods become the preferred method of instruction. Such a change can be most easily effectuated if my department and university change the standards they use for evaluating faculty to place greater value on active learning.

- (8,12) Find a critical mass of folks interested in interactive, engaged teaching. Make some progress changing the incentive structures.
- (1,4,5,8,9,12) People wanted to see a change in their physical spaces for teaching. They wanted a way to use the MAA IP Guide as a group with their colleagues. They wanted a way to mentor junior faculty, and to receive mentoring if they were junior faculty. They want student evaluations that address active learning, and are less biased against it. They want ways to incentivize good teaching the way that good research is incentivized.
- (1,2,3,6,9,10,11,12) Help incoming faculty to make this shift, given them concrete practices, be more open about sharing what goes on in the classroom, more about what active learning looks like, institutional support for class setup, more collaboration in developing materials, more help on implementation.
- (9) Facilities that facilitate group work and board work (group tables, boards on walls).
- (3,8) Chairs/leadership encouraging MAA IPG-reading club.
- (7,10,11) Identifying different types of active learning: group work, IBL, etc.
- (1,14) Encourage/enable postdocs, adjuncts to implement active learning.

What would you personally most like to do or work on toward adoption of active learning pedagogy?

- (3,8,13) As department head, I would most like to engage the department faculty in discussions on the case for adopting active learning pedagogy and the consequent need for the faculty who are not currently using it to give it consideration. In the process, I hope to convince the Professional Assessment Committee to highlight active learning pedagogy as the gold standard for effective methods of instruction.
- (11,12) Collaborate with faculty on what I already do, sit in on each other's classes, better time management, learn how to find more resources and develop my own.
- (12) Collaborate on making teaching public. Why do people refuse to be observed by you? Fear of being judged?

• **Question 2.**

What are the steps you see in order to achieve what you identified in Question 1?

- At the department level, I would like to enlist the faculty who have already adopted active learning pedagogies to join me in taking the following steps:
 - (5,8,10,13) Compile and share data showing that active learning pedagogy is more effective than other pedagogies. The more local the data the better.
 - (7,10,11) Gather/curate materials that have been developed for specific courses, but are not in wide circulation, to help minimize the amount of work and effort required to adopt and implement active learning pedagogies.

- (1,10,13,14) Offer/provide professional development to any faculty member who is interested in adopting active learning instructional methods in their classes.
- (3,8) Engage the departmental Professional Assessment Committee and the dean in discussions about changing the reward system so that the faculty who adopt active learning pedagogies get credit for doing so.
- (10) At the institutional level, I would like to reach out to the Center for Excellence in Teaching and Learning to see if the staff there can help.
- (4,5,8, 12) Steps to changing incentive structures:
 - Changing what “counts” for tenure and promotion decisions.
 - Changing teaching evaluations (including changing the questions).
 - Creating incentives for trying new pedagogical strategies (including \$\$ for professional development).
 - Building intrinsic motivation among faculty for adopting these strategies.
 - Creating incentives to making teaching public.
 - Maybe creating department-level statements (like the CBMS statement) about active learning.
- (12,13) Start small; identify colleagues; find allies; use a Reading Group to focus on IP guide.
- (13) It isn’t all or nothing.
- (12) Give common tests (write together), collaborate on grants, attend IBL workshops together, start with those who are open and willing, ask to come sit in their class, start with just 10%, start with a colleague’s materials, then tweak and make it your own.
- (12) Use peer observations.
- (13) Talk about what students do and need; this is less threatening.

What are the main challenges you and your colleagues would need to overcome?

- (8) The main challenge is overcoming “inertia” (the tendency to resist change), both on the part of the colleagues in the department who are stuck in their old ways and on the part of an entrenched institutional reward structure which is resistant to change.
- (8,13) Pure mathematicians are sometimes not convinced by mathematics education research.
- (8,9) We have lots of challenges, including many structural ones (physical spaces, cultural inertia, incentive structures, lack of professional development built into the higher education model, large number of adjunct and term instructor positions) - much of this is, at its core, really about the R1 business model.
- (1,14) Lack of influence (grad students/postdocs); lack of experience/knowledge; advice from mentors that too much emphasis on teaching makes one look like a less valuable researcher; stance of supervisor; weight of the curriculum (i.e., not in

a position to change it, and there isn't enough space to try pedagogical techniques that take longer).

- (2,10,11,12,13) Lack of expertise, a lack of confidence, and a lack of time. If there were a visible group of people doing active learning at the institution a person could be mentored.
- (2,3,10) No training, no visible community. Need an awareness of why it is useful. If you're not in the know, you're not in the know. No onramp for active learning.
- (1,10) 1st and 2nd year faculty - isolation - no community, no discussion or discussion is inaccessible. Need for a ramp on - how do you learn to do this and how do you feel supported in the learning. A grad student wanted more guidance in active learning.
- (2,10) More people need to rise as leaders - not be appointed necessarily - but gather groups together to talk about and try active learning. I think the resources on David Pengelley's website give an excellent place to start. More spreading of the word on that would be great.
- (9) Money for space.
- (4,5) Evaluations that are biased in favor of lecturing, since many have not changed in a very long time.
- (12) We are not open about what we do in our own classes.
- (14) Support leading from below (grad students, postdocs, early career): lack of experience, lack of influence, CV building, buy-in/support from superiors, being valued, too much "required" material (breadth/depth trade-off), being part of the conversation, not expected/invited to contribute as a grad. student.

• **Question 3.**

What are existing resources and models which you can build on?

- (1,6,7,10) The university Center for Excellence in Teaching and Learning (CETL) is a good resource for active learning pedagogies. The main weakness of the CETL is that it only offers general help and lacks discipline (aka, mathematics) specific expertise.
The Academy of Inquiry Based Learning (IBL) website is a terrific resource. The IBL Video Series are phenomenal and showcase models for novices to use. The site also features textbooks, links, and course materials developed by IBL experts.
- (1,4,5,6,7,10) Existing resources: MAA Project NExT, IBL (and MLI), Regional Networks, CoMInDS. For teaching evaluation: SALG and IDEA center.
- (4,5) A great resource would be examples of teaching evaluations based on the Instructional Practices guide.
- (8) Internal grants for research can be used to model novel programs that include internal grants for teaching skills development.

- (10) People don't get stuck on the content, it's the "how to" part, the nuts and bolts (2 decks of cards). Can you get teacher ed folks to come talk to your group? A teaching seminar for faculty? Focus more on what *students* do, rather than faculty.

What do they help address and what do they leave open from the steps and challenges you identified in Question 2?

- (8) They address how to get started for those who have decided to give active learning pedagogies a try. They do not address the issue of institutional change which is essential for wide scale adoption of active learning pedagogies.
- (8,11) Learning aides on campus. Problem; lack of time.

How do you see using them in your plan to achieve your goals from Question 1?

- (8) I will start by sharing these resources with the faculty in my department who have not yet adopted active learning pedagogies. I will also share these resources with my dean to underscore the fact that the trend toward active learning pedagogies is gaining ground throughout the nation and that our college needs to get on board for the benefit of our students. My hope is to get discussions on changing the reward system in the university started.

• **Question 4.**

What do you feel is needed (not covered by what you found in Question 3) locally, regionally, or nationally, in order to support what you would like to do or see happen?

- (8) How do we package evidence to convince department chairs and administrators.
- (2,8,10) I feel that access to and support for professional development for faculty who may be willing to experiment with active learning pedagogies but feel unsure about where and how to begin is needed. The mathematics professional organizations should be able to help. I would also like to see information on which universities have changed their reward structure to allow active learning pedagogies to count as a valued activity for purposes of tenure and promotion.
- (10,11) A "kit" that goes to departments to show how to get things started; a department seminar on educational practices; AMS COE could create a list of expert speakers who would be willing to come speak at such seminars, lending professional credence to issues of teaching.
- (11) People need to see lots of examples of what can be done.
- (8,12) At conferences, MAA/AMS should have pedagogy sessions/component tied to each math course area. Don't schedule against the research sessions. When we go to give a talk and work on research, ask to sit in on classes.
- (7,11) Need textbooks designed for IBL.

- (10) RUME folks could do more interpreting of math ed research for mathematicians, e.g., what does this mean for me when I go into my calculus class?
- (8,10) Formalizing via workshops and conferences, book club groups to learn more (e.g., MAA IPG), MAA section meetings, NExT sections, virtual resources (MIT seminar)
- (8,10) Normalizing education talks at seminars/colloquia; lists of visiting lecturers to give these talks.

In particular, what kind of curricular or training materials or other supports (e.g., clear recommendations to administrators) would you like to see developed nationally?

- (3,7,11) Curricular guides and training materials, similar to the MAA curricular guides, and recommendations to administrators giving active learning pedagogies the imprimatur of the mathematics professional organizations (in addition to the marvelous CBMS statement on active learning) would help nationally.
- (7) New publishing models and systems for pedagogical materials including worksheets, think-pair-share questions, applets, discussion of areas of difficulty and common students responses and plans for addressing them, and other materials which support active learning, along with textbooks, which combines features of the arXiv, MathReviews, MathOverflow, Curated Courses & UTMOST, Webwork, COMINDS training materials site.

Financed by course fees, with AMS/MAA as fiscal intermediary (new financial model), keeping more money in the community and saving students money.

In the meantime... more robust, high-profile blog networks (#MTBoS) where people share key experiences and favorite materials and approaches.

And what kinds of professional networks would you like to have available so that you can share experiences and insights with others in similar contexts and/or having similar goals, as you engage in this work?

- (8) Sectional meetings of mathematics professional organizations can have sessions on active learning pedagogies.
- (7,8,12) Small, working communities of practice in both research and teaching. On the research side, looks like Women In... model of collaborative work on an expert-chosen problem and/or REUF. But also have pedagogy leader(s) to also focus on producing some materials (worksheets, texts, applets, discussions of practice) addressing a problem of pedagogical practice as well. In the meantime ... common practice to have a pedagogical session as part of research conferences, especially graduate training conferences.

Resources

- NSF press release Enough with the lecturing (2014)

- CBMS statement Active Learning in Post-Secondary Mathematics Education (2016)
- National Research Council: Reaching Students: What Research Says About Effective Instruction in Undergraduate Science and Engineering (2015)
- MAA Instructional Practices Guide (2017)
- Guidelines for Assessment and Instruction in Statistics Education (GAISE) (2016)
- MIT Electronic Seminar on Mathematics Education
- AMS Blog on Teaching and Learning Mathematics
- College Mathematics Instructor Development Source (CoMInDS), MAA
- Project NExT (New Experiences in Teaching), MAA; & Project ACCESS, AMATYC
- Undergraduate STEM Education Initiative, AAU
- Student Engagement in Mathematics through an Institutional Network for Active Learning (SEMINAL), APLU
- Academy of Inquiry Based Learning
- Journal of Inquiry-Based Learning in Mathematics
- Initiative for Mathematics Learning by Inquiry (MLI)
- IBL Special Interest Group of the MAA
- Transforming Post-Secondary Education in Mathematics (TPSE Math)
- Process Oriented Guided Inquiry Learning (POGIL)
- Innovative Teaching Exchange, MAA
- Innovations in College-Level Mathematics Teaching, AMS
- Learning Assistant Alliance; & Learning Assistant Program (UC Boulder)
- Accelerating Systemic Change Network (ASCN)
- NSF Division of Undergraduate Education
- MAA Progress Through Calculus studies
- AMATYC Webinar series
- Center for the Integration of Research, Teaching, and Learning
- Active learning resources from David Pengelley: <https://web.nmsu.edu/~davidp/>

- Active learning resources from Robin Pemantle, including pedagogical tips, and materials for calculus and teacher preparation courses:

<https://www.math.upenn.edu/~pemantle/Active-resources.html>

- Active learning course materials from Matt Boelkins, Steve Schlicker, and Ted Sundstrom, for courses in

Active Calculus (single and multivariable): <https://activecalculus.org/>

Active Preparation for Calculus: <https://gvsu.edu/s/0Ui>

Mathematical Reasoning: Writing and Proof: <https://scholarworks.gvsu.edu/books/9/>