The Early Career Section offers information and suggestions for graduate students, job seekers, early career academics of all types, and those who mentor them. Angela Gibney serves as the editor of this section with assistance from Early Career Intern Katie Storey. Next month's theme will be on community. All Early Career articles organized by topic are available at `https://www.angelagibney.org/the-ec-by-topic`.

Teaching and Learning Mathematics

Conferences—an Owner's Manual

John E. McCarthy

I have just attended my first in-person conferences since the start of COVID. They form a critical part of our profession, so I decided to write my opinions about how to maximize their benefits. I say nothing of online conferences, because I don't understand them.

1. Personal History

The first out-of-town conference I attended was at the University of Arkansas in April 1988. There was a mini-course of five lectures by Harold Shapiro on Quadrature Domains, and individual lectures by other senior operator theorists and complex analysts (in those days, graduate students rarely traveled to conferences, and never gave talks). My adviser, Donald Sarason, had arranged for several of his students to go, and to share a room in a hotel (a Hilton! I had heard of the luxury hotel brand, but had never set foot in one, let alone slept in one.)

This conference turned out to be the most important event of my professional life. I found it terribly exciting—real mathematicians talking about their work and progress on interesting problems. I could understand the statements, even if the proofs were complicated. Outside the talks, the professors talked to the graduate students as if we were real people. Allen Shields even invited me to join a group for dinner. (Unfortunately I was too shy to accept—a foolish mistake.) At the conference banquet, I sat at a table with several professors who chatted with us, and Philip Davis gave a fairly long after-dinner speech that was witty, interesting, and for me the highlight of the evening.

Before I went to the conference I was feeling somewhat desperate. I was in my fourth year as a PhD student, had no results, and every time I sat down to work the sense that I had to prove something RIGHT NOW caused my anxiety

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and blood pressure to spike, making progress even more difficult. I was starting to believe that I would never finish my degree.

After I came back, I was newly enthused about mathematics, and within two weeks had proved a theorem that turned into my thesis. After my adviser signed off on my thesis, with the psychological burden lifted, I became a much better mathematician.[1] Quadrature domains, which I had never heard of before the mini-course, have turned up in my professional life in unexpected and interesting ways. Many of the people I met at that conference became friends.

Since then, I have attended numerous conferences and organized several. Some have been more enjoyable than others. Here are my personal opinions on what makes for a good conference.

2. The Participants

Mathematics is a human activity (see [M1] for my thoughts on this), and a social activity. We may prove theorems on our own, but we need to communicate with others. Conferences serve several social functions, the relative importance of which change over one's career.

- They serve to educate—we learn from the talks, we learn from discussions, and we learn from conversations at meals. We learn both mathematics, and mathematical culture.
- They serve to advertise—here is my new theorem! Let me explain why it is interesting!
- They serve to socialize. When you go to your first conference, you probably only know a few people from your own university. But over time you get to keep meeting people you have met before, some of whom become friends, even close friends.
- They serve to network. This is like socializing, but there is a subtext of helping you professionally. After all, you are much more likely to get a job offer from a university if someone on the faculty there has seen you talk.
- They serve to inspire. I am really impressed by the theorem the speaker is telling us about. Next year I want to be on the stage talking about my own impressive theorem!
- They serve to enthuse. Mathematics is really interesting and fun!

Conference attendees are a heterogeneous group—graduate students, postdocs, junior faculty, senior faculty, some mathematicians who are close to the core theme of the conference, some who are quite far from it, occasionally undergraduates and non-professionals. They all bring different things, and want different things from the conference. For the conference to be successful, they must all cooperate.

[1] *It is bizarre that you spend 5 years as a PhD student, essentially writing your first paper, and then you are told that to be competitive you now have to write multiple papers a year. Amazingly you can. If someone could only write down whatever the magical knowledge is that one acquires writing a dissertation, PhD completion times could be reduced to a year.*

3. Conference Talks

There are several excellent articles on giving mathematical talks; see for example the essays by B. Kra [M2] and T. Tao [M6] on talks in general, and the post by W. Ross [M5] on 20 minute talks in particular. My views on colloquium talks are here [M3]. In this essay, I will confine myself specifically to conference talks.

- The best medium for most mathematics talks is a blackboard, perhaps with some interruptions for graphics. This is for two reasons. The mathematical one is that blackboards allow far more material to be visible, so the audience can check back on definitions and statements. The psychological one is that it forces the speaker to proceed slowly, since it takes time to write. (See V. Peller's essay [M4] for the advantages of the blackboard).
- At many conferences blackboards are unavailable. If you are giving a Beamer talk:
  - GO SLOWLY and don't show a lot of writing.
  - Theorem: For an N minute talk, the optimal number of slides[2] is $\frac{N}{2}$.
  - Any number larger than N is malpractice. It takes much longer for the audience to absorb ideas and statements than most speakers realize.[3]
  - Never put a full paragraph on a slide. Write the minimum necessary—it does not have to be in full sentences. We are all conditioned to read whatever is put in front of us.[4] Time spent reading is time not spent listening to the speaker.
  - Do not end with a slide that just says "Thank You." Your last slide should contain your main result(s), so that audience members can look at it while absorbing your talk and thinking about questions.[5]
- There may well be people in the audience who heard you talk on a similar theme before. Don't let this influence your presentation. Many other people in the audience haven't attended your talk before, and even the ones who did attend don't remember very much about it.
- Know the mathematical range of the audience. Try to make the talk worthwhile for all of them, not just a couple of experts.
- Everybody in the audience has chosen to attend your talk, instead of spending their time proving a theorem (or whatever else humans do when they are not attending math talks). It is your obligation to make sure their faith in you is justified, and the time at your talk is well spent.
- A good talk takes a lot of preparation. Don't cheat your audience by not preparing properly. Do not use a

[2] *You get the title page for free.*

[3] *I find my ability to absorb decreases over the course of the conference, as I get more tired.*

[4] *This is why billboards are a driving hazard.*

[5] *You can put "Thank You" on the last line if you want—a good use of the pause command in Beamer.*

set of slides or notes from another talk—make a fresh preparation for this particular audience. Of course, there may be significant overlaps with prior talks, but your emphasis should shift depending on who the audience is (and what the theme of the conference is). Two-thirds of a good 60 minute talk is not a good 40 minute talk.

- Don't go over time. The chair of the session should give the speaker a sign when there are five minutes remaining, and stand up when the time is up.[6]
- If you like the talk, tell the speaker. Everybody likes positive feedback. And if nobody is coming up to you after your talk to tell you they liked it, perhaps you should wonder what you should be doing differently.

4. Social Behavior

- Go to talks, not just by well-known mathematicians.
- Most conferences have plenary lectures (this means no other talk is scheduled simultaneously) and parallel sessions. The purpose of plenary talks is to inform—they should be like colloquia, but aimed at the audience designated by the conference.[7] Plenary talks close to you educate you about your current area of research. Plenary talks far from your current interests may educate you about your future area of research, or at least help you see a bigger picture of where your work fits.
- Parallel sessions have a range of speakers, from senior mathematicians to people giving their first ever conference talk. Attend talks in the parallel sessions too. Remember, everybody needs an audience. You want people to come to your talk, don't you?
- Sadly, not every speaker will have taken the lessons of the previous section to heart, and some talks will be boring. If you get lost in a talk, it is perfectly acceptable to take out a pad of paper and work on your own mathematics.[8] But don't type on a keyboard—this is distracting for the audience around you.
- Questions at the end of talks are great, but it takes time to formulate a good question, especially if the talk covered a lot of material. Sometimes the chair of the session will tap somebody in advance and ask them to ask the first question.[9]
- Talk to people, at coffee breaks and meals. Go out to eat with other attendees at lunch and dinner.[10]
- Introduce yourself to people you don't already know, and talk to them. This is hard, especially if you are junior, but do it anyway. Some of these people will become your friends and collaborators, some will tell you interesting stories.
- If it is a themed conference, there will probably be a banquet. Go to the banquet. Try and ensure that some of the people sitting at your table are people you don't already know.[11]
- Conference Organizers: Try to have the banquet in a venue where everybody at a table can hear everybody else near them. This means not too much background noise, and either small round tables (8 people maximum, 6 is better) or rectangular tables.
- It is traditional for the first speaker at the conference to give a speech at the banquet.[12] This speech doesn't have to be long, but it should have some message in addition to thanking the organizers.
- Organizing a conference is a lot of work. Don't make unreasonable requests of the organizers.
- Organizing a conference is a lot of work. Thank the organizers!

5. Summary

Conferences are central to the practice of mathematics. Their success relies on your efforts as an attendee. This includes being a good audience member, being a good speaker if you have the privilege of speaking at the conference, and making an effort to socialize, especially with people you don't know, or who seem to need some help gaining entrée. Done right, conferences are enjoyable and stimulating, and you will go home with a renewed enthusiasm to do mathematics.

References

[M1] Journal of Xenomathematics, `https://www.math.wustl.edu/wp/mccarthy/publication/journal-of-xenomathematics/`.

[M2] Bryna Kra, *Giving a talk*, Notices of the AMS **60** (2013), no. 2.

[M3] John E. McCarthy, *How to give a good colloquium*, Canadian Mathematical Society Notes **31** (1999), no. 5, `https://www.ams.org/profession/leaders/workshops/gcoll.pdf`.

[M4] Vladimir V. Peller, *Utilization of technology for mathematical talks. an alarming situation*, 2012, `https://arxiv.org/pdf/1204.5141v1.pdf`.

[6] *Boris Korenblum famously unplugged the projector when a speaker went over time and wouldn't stop.*

[7] *So at an AMS meeting, a plenary talk should be just like a colloquium. At a conference on Hilbert Function spaces, the speaker can assume that the audience already knows what Hilbert Function spaces are, and believes them to be inherently interesting. But the speaker still has to convince the audience that their particular subtopic is interesting.*

[8] *Don't do this too early in the talk—once you stop paying attention, you won't be able to jump back in.*

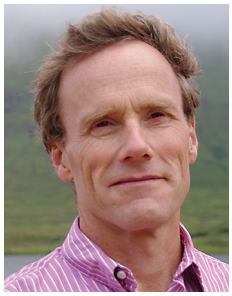
[9] *Sometimes it is hard to ask a question because the speaker anticipated the natural questions and answered them during the talk. Here is a good question if it hasn't already been answered: What is a very simple application of your theorem?*

[10] *Do this in manageable groups. Having 20 odd mathematicians walk down the street looking for a restaurant for lunch where they can all sit together is ridiculous. Once the group exceeds 6 or 8 you can only talk to those sitting close to you anyway, so you may as well start in a smaller group.*

[11] *If you already know everybody at the conference, good for you! I have nothing to teach you.*

[12] *If for some reason they cannot give the speech, they should arrange for somebody else to do so.*

[M5] William T. Ross, *How to give a good 20 minute math talk*, 2008, https://blog.richmond.edu/wross/2008/03/26/how-to-give-a-good-20-minute-math-talk/.
[M6] Terence Tao, *Talks are not the same as papers*, 2009, https://terrytao.wordpress.com/career-advice/talks-are-not-the-same-as-papers/.



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Credits

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Learn from the Masters: A Case for the History of Mathematics

Amy Shell-Gellasch

Interesting fact about me. I have undergraduate, master's, and doctorate degrees in pure mathematics, yet only took one class in my research area, and many of my colleagues have taken no classes in our research area. I have taught mathematics at the college level for 30 years, yet rarely teach a class in my research area, in fact, most colleges and universities don't offer classes in my research area. But surprisingly, my area of research informs all areas of mathematics, and is one of the most accessible areas of mathematics for students of all levels, and for things like capstone research and REU topics. Who am I? I am an historian of mathematics.

Yes, that is a thing, as I have had to tell many people. In fact, given that the earliest evidence of "writing" in the form of tally marks is mathematical, the history of mathematics constitutes the oldest branch of recorded history. So how did I become a math historian? Like many non-mainstream careers, it was unplanned. And due to just one class and one professor: a History of Calculus course I took during my master's work at Oakland University (Rochester Michigan) taught by Dr. Steven Wright. Seriously, it was one of the hardest classes I took in all my graduate work. Taking what we would deem a simple derivative the way Newton did took about two pages of geometry and calculations using Newton's less than stellar choice of notations. (One reason Leibniz's work was so important was that his notation was so insightful it actually helped move the development of the calculus forward.) I fell in love with the topic, and the rest is history, so they say.

After starting a PhD program in applied mathematics, I found the Doctor of Arts in Mathematics program at the University of Illinois at Chicago that gave me a full PhD education in mathematics but allowed me to do a dissertation on an historical topic. However, there was no class on the history of mathematics. In fact, IF a school offers a history of mathematics course, it is usually either a general education course (which is a topic for another paper, but a fantastic way to get non-STEM students interested and comfortable with mathematics), or a course for future K–12 mathematics teachers. So how did I learn to be a historian of mathematics? You may ask. Well, I did what 90-something % of all historians of mathematics did, I read. I read and I read and I read. I also connected with established historians and learned on the job so to speak.

Another question you may now be asking is why should you be interested in the history of mathematics? Let me start with a common lament in mathematics, "if they had only asked us!" We often hear about a scientist in another field being stalled because they did not have a way to process or interpret what they were seeing in their data. They often develop ad hoc methods to handle their data, only to find out later that what they needed was ready and waiting for them in mathematics. Not as well known is that this also happens within mathematics itself, when a mathematician unwittingly reinvents a process that was invented earlier or published in another language. Thank goodness Galileo and Kepler knew their Greek conic sections: a theoretical piece of mathematics that waited almost two millennia to be of use. Thus the short answer to why the history of mathematics is important is two-fold. One—if you are doing mathematics you should know the history of what you are doing. Unlike in experimental sciences, mathematical techniques that seem like dead-ends or unimportant at one point in time may provide insight or even be considered groundbreaking later on. Take for example non-Euclidean geometry. The story of the discovery by Lobachevsky and Bolyai (and Gauss) is a well-known example of this. Two—imparting (some of) the history of the mathematical topics you teach to your students provides numerous pedagogical benefits. No time to go into this in detail, but I will list one: DEI (diversity, equity, and inclusion). By presenting some history of mathematics or ethnomathematics your students will realize that mathematics is not done only by old white men who are geniuses, but by all kinds of people, and that mathematical discovery takes time, dedication, passion,

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