

How can we give better talks?

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One of my favourite experiences as a mathematician is attending a good talk. I love the chance to perceive a mathematical world through someone else's senses. I love the shared excitement and concentration in the room that a good talk can elicit. I love the sense of understanding that a good talk can give, sometimes short-cutting many weeks struggling with technical papers.

On the other hand, a lot of talks are bad. For mysterious reasons we have a culture of putting up with bad talks, despite their dubious value. This aspect of our mathematical culture is surprising, given how much there is to gain from good talks.

This article is part of a series which attempts to give practical advice on giving better talks. I believe strongly that this is an aspect of our culture that we can improve, and that putting effort into change is worthwhile.

Several excellent sources of advice for giving good talks already exist: for example, [Hal74, McC99, VV23, Kra13, Dev19, Ell05] provide excellent advice for mathematicians, and [Jon16, Win19] are classics for general scientific talks. Several of these sources discuss nuts and bolts, such as “write legibly”, “don't go over time”, etc. I'll assume these nuts and bolts are in place below.

My main thesis is that good speaking is a skill that can be improved, but improvement requires a feedback loop. That loop has three parts: preparing carefully, forming a model of the audience, and learning from what actually happened. I discuss these in reverse order.

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1 Feedback

One of the best ways of improving at something is to get expert feedback. As professional mathematicians, we have several means of getting feedback on our research (referee reports, discussions with colleagues, assessor comments on grants, ...). However, we lack means of getting honest and constructive feedback on our talks. Thus we often don't know whether we have given a good talk or not.

1.1 We don't seek or give honest feedback

How many times have I heard someone mumble “nice talk” after an awful talk? This ritual politeness does little to help us improve [McC99]!

We *should* seek honest feedback:

1. “How did you find my talk?” If they say it was great, which people usually do out of politeness, follow with: “Is there anything I could have done better?”, “What do you remember?”, “What would you remove?” ...
2. If someone says they got lost, ask “At what point did you get lost?” This is extremely useful information.
3. “What were the best talks at this conference?” Over time you can compile a mental model of what different types of mathematicians like, and learn tricks and taste from your colleagues.

I have asked these questions hundreds of times, and I think this is a touch unusual. For this reason, I know that some of my talks were terrible. (Getting honest feedback is not always good for the ego!) I know

that I’m incapable of explaining what a transformer is in a general audience talk. I know that the squiggly curves that algebraic geometers love to draw are incomprehensible to outsiders. I know that people generally respond well to more philosophical asides, even if these are the aspects of my talks that I find the most problematic. As an audience member, I have a much better idea nowadays when most people in the room are lost, and it is time to interrupt the speaker. This is *all a consequence of actively seeking feedback*.

1.2 Feedback is high variance

Many years ago I went with some friends in Berlin to a film festival. One evening, four of us went to a film. I can’t remember much of the film, except for the fact that I found it deeply unsettling. Afterwards, we sat at a bar, and I was shocked at the variety of responses the film had elicited. I had incorrectly assumed that others would be troubled like me. This was not the case at all. One friend had been overwhelmed by the beauty of the animals, another had noticed a strange cycle in the film’s storytelling, and another had just been bored.

After having asked many people at a conference which talks they liked and didn’t like, and why, I’m struck by the great variety of responses. The spectrum of “mathematical taste buds” is enormous. A simple formula or analogy may speak volumes to one person, and be meaningless to the person sitting next to them. This also means that we shouldn’t be prescriptive about what a good talk should be.

This is particularly important to keep in mind whilst soliciting feedback. Don’t just ask the experts, and don’t think that you need to throw everything out just because one person didn’t like your explanation or style.

1.3 Incorporating feedback

It probably goes without saying that there is no point in soliciting feedback unless you actually change your talk! If the feedback is overwhelmingly negative, I typically abandon the talk almost entirely, and start over. Every time I have done this the result is a simpler talk which is better received. If parts of the

talk work, and others don’t, it can be useful to divide the talk into the “bits that work” and the “bit that doesn’t” – your job is then to find a replacement part for the “bit that doesn’t”. If you have to give a similar talk several times in a row (e.g. a seminar talk at various departments) it seems a wasted opportunity to give an identical talk each time. Instead, experiment with variations and try to gauge their effect (keeping in mind that feedback is high variance).

2 Modelling the audience in your mind

In order to achieve something consciously, you need to know what you need to do to achieve it. If you want to communicate an idea, you need to know where this communication will start and finish. Communication begins with what the audience knows already. Thus, you *must have a mental model of your audience*. Like all models, this model will be wrong. But making sure it is not too wrong is important.

Having a mental model of your audience is hard for two reasons:

1. Modelling someone else’s knowledge and mental world is always hard.
2. Typically, an audience has many members. Thus, you either get to know every audience member’s mental world (always hard and often impossible!) or you form a picture of the distribution of your audience’s knowledge.

Developing this mental model is part of mathematical maturity. You can work on the first point every time you have a mathematical discussion with someone. Did they follow that? Did they really understand that or are they just saying they did? What do they assume of me when explaining things to me?

2.1 Modelling the audience before your talk

It was a real breakthrough for me to realise that many of my difficulties in giving a mathematics talk are caused by uncertainty around others’ knowledge and

access to mental imagery. As a rough rule of thumb, the greater uncertainty there is in my knowledge of the audience, the more time I need to prepare:

1. For a seminar talk in my own department, I have a quite precise knowledge of what everyone will know. In this case, I can write a talk in a few hours.
2. For a colloquium talk in another department, I know that I can assume basic mathematics, but not much beyond that. In this case I probably need a few days to prepare.
3. For a public talk, the uncertainty is extreme. Also, there will almost certainly be people with PhDs there. It can take weeks to prepare a talk that will not lose the layperson, but still offer something for the expert.

2.2 Modelling the audience during the talk

Really good speakers can read the audience as they give the talk, and alter the pace, give additional explanations etc. as the talk progresses. This is a very hard thing to do. In my experience, it is helpful to show genuine openness to questions and interruptions. These give crucial feedback on how the audience is responding. Some suggestions for welcoming questions and interruptions:

1. Don't go too fast, and state explicitly that you are not wedded to getting to the end of the talk. ("I want you to understand something, and I don't care if I get to my big theorem" is a great message to give an audience!) For larger audience talks, it is helpful to have a talk which you know isn't quite long enough to force yourself to slow down.
2. Welcome questions during the talk by turning and facing the person asking the question and genuinely listening. When asked a question, many speakers stand there staring at their toes and basically waiting for the person to stop talking. Try not to do this! Once the question is finished, acknowledge it, and try to honestly answer

it. Don't shut down further audience comments, as these can be extremely valuable.

(Of course, sometimes questions and interruptions can go too far. Less established mathematicians are more frequently victims of this problem. Dealing with this situation is an important skill that we won't discuss here.)

2.3 The mental state needed to model the audience

The energetic, adrenaline-fueled state that most people give talks shuts down openness to the audience. I suspect that we are at our most empathetic when least excited or scared. A fear response is natural, but it is important to try to temper it.

Each person has an optimal level of nervous energy when giving a good talk. For me it is lower than my natural excited pre-talk state. Here are some techniques that I use to try to relax a little before an important talk:

1. If possible, try to spend some time in the space (e.g. in front of the board, or on the stage) a day or two before your talk.
2. If you are using technology, make sure it is all set up 10–15 minutes before your talk.
3. Find some space to sit quietly for a few minutes just prior to being introduced. If someone tries to talk to you, tell them you need some quiet.
4. When you are introduced, don't start speaking immediately. Instead, look at the audience and wait for that beautiful and slightly unsettling silence as the audience wonders why you're not speaking.¹
5. The first words you say are very important. Have your first few sentences memorized and say them more slowly and with longer pauses than comes naturally. Face the audience and really look at them.

¹I learnt this trick from the pianist Sviatoslav Richter [Mon97]. Halmos [Hal74] also comments on the power of silence in a slightly different way.

2.4 Dealing with dead patches

Anyone who has felt the beauty of an engaged audience has also had the unsettling experience when the audience is suddenly lost. These “dead patches” do not mean your talk is done for! In fact, recognising that you have gone too quickly builds trust with your audience. Here are some techniques to rekindle a talk after a dead patch:

1. In small audiences, acknowledge that some people might be lost. “I think I went a bit too fast over this stuff. Does anyone have a question?” This only works if you didn’t lose people too long ago. I’ve asked students in the past why they didn’t ask a question. They often say things like “I was so lost at that point that I didn’t think the situation was salvageable.”
2. A common technique is to give the audience another on-ramp. “Even if you didn’t understand those last few slides, the following fundamental point is important.”
3. In larger audience talks, long pauses can function as a “reset” button.
4. As a general rule, trying to solve dead patches with more energy is a bad idea, particularly if you are a high-energy lecturer. At this point the audience associates your high-energy with their lack of understanding, so dialling up the energy just increases the anticipated lack of understanding.

2.5 Modelling the audience in large talks

For bigger audience talks when you can’t invite questions it is much harder to gauge where the audience is at. Geometry of the space and placement of people in the room make a big difference. For a large audience dispersed in a big room the situation is nearly hopeless. If everyone is more tightly packed, however, one can gauge the energy better.

It is a beautiful and rare feeling to be in touch with a large audience. If you are lucky, you can feel the

impact of what you say moving like waves across the room.

3 Preparation

“The present letter is a very long one, simply because I had no leisure to make it shorter.” Pascal, [Pas23, Letter XVI]

Pascal’s sentiment applies just as well to talks as it does to letters. Most talks are too long, too full, and don’t have a clear direction. This is largely because most talks are under-prepared.

How should you spend time preparing? It is often useful to channel Pascal and first prepare a talk that is much too long (e.g. two or three times the length that you need), and then slowly cut it down, asking yourself what is really important at every step. During this process it is often useful to ask questions like: “What is the main point of this talk?”, “What story am I trying to tell?”, “How does this bit contribute to my main point?” . . .

It is also worthwhile spending time trying to form a mental model of the anticipated audience. If visiting a new department, it is a good idea to look at the department website to see the areas of interest of faculty members. If you are a younger researcher, it can be worthwhile to ask senior members of your department who is likely to be at the conference or colloquium, and what their background is. If you are giving a public lecture it is worthwhile *asking* members of the public if they know something you assume they must.

It would be remiss not to emphasise how much time this all takes! I once discussed preparation with Karl Kruszelnicki, Australia’s best-known science communicator. His rule of thumb was that every three minutes of content needed an hour of preparation . . . and this is coming from a professional!

Once you have prepared your talk it is important to give several practice talks prior to the main event. For my first talk at the ICM, I gave versions of my talk at least 10 times to different audiences. For really important talks it can be reassuring to memorize timings (e.g. “I get to the big diagram after 23 minutes, and the discussion of Gabriel’s theorem at 41

minutes”). It is also a good idea to schedule a practice talk at your home institution first.

[Win19] Patrick Henry Winston, *How to speak*, 2019. Lecture delivered at MIT IAP 2018; video published 20 December 2019.

4 Conclusion

One of the pleasures of a good talk is that, for a brief moment, we are allowed to inhabit somebody else’s mathematical world. This is not easy. But with a culture of open and honest feedback, careful attention to the audience, and a real desire to improve, we can all get better at it. When it works, mathematics that existed in one person’s mind becomes something shared.

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