Soft skills for Mathematicians

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Preface

This book has been written when giving a PhD course at the Department of Mathematics and Stockholm University on 4 occassions between 2014 and 2024.

Thanks to ...

Chapter 1

Oral presentations

Giving talks about your research is the second most important way to spread information about your research results, writing scientific papers being the first. In the current chapter we give some advice on how to give talks. This should not be mixed up with teaching mathematics, the latter being outside the scope of the current text. When teaching in higher education, focus should be on the students and that they are active and learn. Giving a scientific talk is more of one-way communication (even if some interaction may be desirable), where you have a result you want to present.

Giving presentations at conferences, workshops and departments is an important way to spread the information about your results, but also about you. The networking aspect of giving presentations should not be underestimated. Another important reason for giving presentations is that you may get valuable feedback on your work which might improve it, lead to new research questions and/or initiate new collaborations. I therefore strongly encourage you to always give oral presentations when attending conferences or visiting departments of your colleagues. You don't have to give a new presentation each time you give a talk. If you have a nice result in a paper it is perfectly fine to give the same talk several times (or at least similar - the audience and time limits may differ!). If there are one or two attendants who have heard it before, they can just choose not to attend, and if they do attend they will probably learn more of the contents in the presentation after hearing it a second time.

An alternative to giving talks at conferences is to have a poster. I have no personal experience of presenting a poster, so even if this is another important presentation technique to learn I refrain from giving advice on pre-

senting posters due to lack of experience. I however have some experience from viewing posters. Usually there is a specific time for poster viewing at conferences, often combined with drinks and snacks to attract more people. From a viewers perspective I think it is very important to have a clearly visible and informative title, and not to cover this with your head or body when you are present at the poster session. If there are many posters I typically only want to hear more about a fraction of the posters, and seeing the title from a distance helps viewers decide which poster-presenters to approach and which not to approach.

1.1 Preparation

There are different forms for giving a scientific talk: a seminar in a department, a presentation in a smaller research group, a contributed talk at workshop, or a plenar talk at a major conference. The smaller the audience the bigger possibilities for some interactions, but I would still say that the type of presentation can be quite similar in all these situations.

1.1.1 What and for whom?

As when writing, the mathematical contents is of course the start when preparing for a talk. Here we assume that you want to present the results of a paper you have just finished and submitted, but other contents would be structured similarly. Secondly, just like when writing, you should consider whom you are talking to. Nearly always this will be a more disperse audience than the readership of a paper. For example, at a department seminar there are often PhD students, Post Docs and professors, some working in areas rather different from your area, and others closer to you. Finally, there is often one ar a few real experts in the area, e.g. the person who invited you. The situation is similar when you talk at conferences. Your ambition should therefore be to devote some time to all these categories. As Halmos (1974) puts it: the first 25% of the talk should be directed to a general math-educated student, the next 25% of the presentation should be directed to a PhD student not familiar with your field, the following 25% to faculty non-specialists, and the final 25% to specialist of your research area. Even if this should be the typical progression of a talk it is still important to consider who will make up the audience. If they share some common interest, e.g. through

a theme of the conference, this could affect what you want to put focus on, what you spend additional time on explaining and what parts that require less attention. Keep in mind when preparing the slides that the audience is heterogeneous so also non-specialists should be able to follow the first part of the talk. And remember that even the specialists know less than you about your particular result, and that typically no one has read your paper (if someone has they will be happy with a layman summary anyway). If you think back on recent presentations you have heard: is it more common that they were too simple or too technical? For me it is clearly the latter. Have this in mind when you produce the slides!

1.1.2 Duration and presentation style

Another related very important thing to have in mind is to lower your ambition. The written paper can take anything between a couple of hours to several weeks to read and understand. Your presentation will perhaps last for 30 minutes, so clearly you cannot expect to explain more than a small fraction of the contents of the paper. If you manage to make listeners interested, those who want to learn more will read your paper.

More things to find out in the preparation phase is how long time you are expected to talk, and which facilities you have access to. Clearly, you will have access to a screen for your computer, but do you also have access to a black/white board, is there sound system for the computer in case you want, will you be using a microphone or just your regular voice, do you have a laser pointer or a traditional pointer? At less formal occasions it is also possible to give a presentation only using black- or white-board. In fact, there is a big advantage with the a blackboard when you describe proofs and other derivations in that it will not be too quick. The downside with presentations using the blackboard is that you will have time to cover much less material. So, when deciding whether using blackboard or computer, you should determine whether you want to present more material sketchy, or if you want to really explain the ideas behind a mathematical derivation. The most common choice, and always at conferences, is to use computer slides.

If you have access to a blackboard on the side you might very well explain some part using the blackboard. I think such "side-steps" make the presentation more lively and interesting. But remember that using blackboard is time-consuming. As for pointer it is convenient to have a laser pointer that also allows you to change slides without approaching the computer. How-

ever, make sure that the light from the laser pointer is strong enough. It is very frustrating to attend talks where the speaker continuously points with a laser pointer to different parts on the slides, but where the laser point is so small that you can't see it. In that case I much prefer a traditional pointer stick.

When talking at a conference the time slot for you is typically very fixed, whereas in a departmental talk it might be a bit more flexible. In the latter case I strongly recommend you to ask in advance for a recommended duration of your talk. In either situation, you should *never* (!) speak longer than you are asked to – if you do you are not showing respect to the audience. If you talk beyond your allocated time the majority of the audience will then: have stopped listening, have become frustrated to why you have not finished, and wonder when you will finish. The remaining impression of you and your presentation will not be the contents of it but the fact that you talked too long.

When you prepare the talk you should hence have the duration in mind. In fact, beside the mathematical contents and the audience, the time limit is the third most important factor when preparing your slides. Once you have produced the slides it is good to give the presentation out loud and to time it, to make sure the amount of contents is suitable. Giving the talk silently inside your head is always quicker so make sure to give it out loud. Even if you have done so, your presentation can take longer when you give it at the seminar/conference, perhaps due to some question during the talk, so check regularly how you are doing with time during the presentation. For this reason, in case you are short on time, you should have a few slides towards the end of the talk which you can skip without loosing the main messages.

1.1.3 Presentation structure

As described above, you should have a lower your ambition in terms what to expect the listener to learn from your presentation as compared to readers of a manuscript. The most important piece of content that you should convey is to explain the question you are addressing, preferably with a short indication to why it is relevant. My impression is that many speakers spend too little time on this and instead rush to the solution of the problem. However, if some or even many listeners don't understand the problem you are addressing and why, they will certainly not be interested in your solution to the problem! So, put quite a bit of effort on explaining the problem and why you want to

solve it. Listeners who understand this but not your solution will still have gained from hearing your presentation.

Once you have presented the problem with some background motivation you should then move on to the results. What have you shown/proven, and also what your results imply within or outside of mathematics. It is also highly recommended to state what you have *not* proven. What interesting questions remain open, and do you have any guess on what the answers are? Describing open problems is a very efficient method to attract listeners' interest. Only after these parts have been presented, and time-permitting, you can give some hints to how the results are proven. Being towards the end of the presentation you can be more advanced here. Still you should focus on the main ideas of the proofs and leave out technical details. Here you can also explain obstacles when trying to solve the open problems.

Some slides towards the end, for example containing proof methodology, some extension or application, can be skipped in case of short time remaining. The last couple of slides should however be shown, and they should end with a summary of the main results and their consequences. Some speakers end with a slide thanking all collaborators and financial sponsors, others by giving some references (both the publication but also a couple of references to related work - don't include all references you have in your paper). I think either of those ways, or to simply end with the last summary slide, is fine. If you don't mention collaborators in the final slide they should appear on the first slide (e.g. "Joint work with x and y"). It is very important that they are mentioned somewhere on the slides.

Another recommendation when presenting is not to treat the most general case of your paper, but to consider some special simpler case. You can explain this orally: "In the paper we consider a more general form of functional but here treat this simpler case for clarity".

1.1.4 Structure of slides

When you prepare the slides it is wise not to include too much information into one slide. The first slide should show the title of the presentation, your name and affiliation and also names of co-authors and possibly financial support if not mentioned at the end. You can then show the outline of the talk, but quite often this is shown at the top or bottom of each slide, also showing where in the talk the current slide belongs, together with your university heading, using suitable LaTex package for presentations.

Figure 1.1: A slide from a presentation. My name, affiliation, the title and sections of the presentation are shown, the current section being bold.

Each slide can have a header describing the contents of the slide, but this may also be skipped. Either way, the slides should use big enough font and not have too much text or formulae. Don't write complete sentences – just the important words. You may for example use "itemize":

- Not complete sentences
- mathematical symbols rather than text: $f_\alpha(\cdot) \in C^\infty,\ \forall \alpha \in (0,1)$
- Leave out details

Keep in mind not to have too much information in any slide, and also not to have too many slides (one per minute could be a good goal). These restrictions agree with earlier statements that you should only present part of the content of the paper and no details about the proof. Another way to reduce complexity in the presentation is to consider some simpler special case when you heuristically explain the ideas of a proof.

When preparing the slides you should only include things you plan to say – it is not recommended to put up additional information (that you don't discuss) on the slides. Sometimes people even use a page from their paper as a slide in their presentation, often saying "you don't have to look at all this, all I want you to study is equation (4)". It is of course much better to produce a slide only containing this equation, and possibly some comments about it! If you have some graphs or figures on some slide this usually makes the presentation more varied, or if you break with a blackboard derivation or a "live" computer simulation producing a figure as the simulations evolve.

Once you have produced the slides you should let them rest for a while and go through them again keeping in mind not to be too technical and not having too much information on each separate slide. It is strongly recommended to give the presentation out loud for yourself. This will indicate the duration of the presentation, but it is also a good way to discover unclear explanations and parts needing better connections.

1.2 Giving the talk

When it is time to present the talk you should of course be there well in time. Make sure that your talk is up on the screen and check that the microphone is working in case you use it. In a large lecture room I recommend using a microphone (assuming the audio system is at least descent). If a speaker talks too silently during a presentation those in the back will quickly loose interest. Asking "Can you here me in the back" (often done with very loud voice) is not very meaningful - very few would raise their voice saying they would prefer the use of a microphone.

When you start the talk you are often presented by a chairman. It is customary to thank him or her (e.g. for the opportunity to present), and thank for the invitation to speak when relevant. You can also state some general comment, like "What a beautiful campus you have", or something making people laugh a bit to make the atmosphere more relaxed. If you are nervous you might also memorize the first few sentences you plan to say in your talk. But, I discourage you to have the whole presentation printed out like a manuscript to read out loud. Reading a text word by word often make listeners become bored. Nor should you read the exact words as they appear on the screen. What you can have is a speakers note (on your screen or on a paper) where you have some key points to mention on specific slides. This could for example be to acknowledge the co-authors on the first slide, that a simulation program can be downloaded from your webpage on the slide where simulations are presented, or similar.

When you speak you should aim for speaking loud and clear. No whispering of end of sentences or of less relevant parts! Don't speak too fast, and when you have stated an important result or observation it is effective to make a small pause for the audience to really capture what you just said.

It is important to try to catch the interest of as many listeners as possible. This can be achieved by presenting an interesting problem, state something counter-intuitive, or to ask the audience to guess the answer to some question. During the presentation you should also try to get eye contact with as many listeners as possible. You should definetely not only direct your attention to some small group of listeners, such as your friends, the experts in the field, or those in front. Try to spread you attention equally to the whole audience.

During the presentation it is important to keep track of time. If you come behind schedule you will have to skip some slides towards the end, but make sure you have time for the very last slides giving the summary, conclusions

and open problems. *Never* talk too long, at least not at conferences and situations where the speaking time is fixed. Speaking a few minutes shorter than your allocated time is however not a problem. Hopefully you will then get som questions from the auditorium.

Make sure you look out in to the audience frequently, and not only at the screen or blackboard. This allows you to follow the audience to see parts where they look interested or puzzled. Some individuals have hang-ups like looking into their hands, scratching a leg regularly, frequently clearing the throat etcetera. Such hang-ups tend to distract listeners and should be avoided. An efficient way to find out if you have any hang-ups is to film a presentation of yours, and afterwards studying how you move and speak. This you can for example do when training for a presentation. Another piece of advice is to ask for feedback on your talk, preferably you should do this prior to the talk so the person hears your presentation when having feedback on it in mind. Just like when writing a manuscript you can team up with a colleague and give feedback to each other. If you are a PhD or Post Doc student you can also ask your supervisor to give feedback. Just like with writing, practicing giving talks, getting feedback (and making observations yourself) and modifying in future talks, is the best process for giving better and better talks.

To be included

Comments from Tobias

What is most common: too simple or too complicated talks? Juniors tend to give more complicated talks

Literature

Gillman, L. (1987) *Writing mathematics well.* Mathematical society of America. Austin Texas.

Halmos, P.R. (1970) *How to write mathematics.* L'Enseignement Mathematique. https://courses.physics.illinois.edu/phys509/sp2022/HowToWriteMath.pdf

Halmos, P.R. (1974) How to talk mathematics. *Notices Am Math Soc*, 21: 155-158.

Higham, N.J. (1998) *Handbook of writing for the mathematical sciences.* SIAM. Philadelphia.

Houston, K. (2009) *How to write mathematics.* University of Leeds.

Knuth, D.E., Larrabee, T., and Roberts, P.M. (1989). *Mathematical Writing.* Math Ass. of Am.

Lee, K.P. (2010). A guide to writing mathematics. http://cc.kangwon.ac.kr/ kimoon/me/me-132/math-writing.pdf

Pak, I. (2018). How to write a clear math paper: some 21st century tips. *J of Humanistic Math*, 8: 301-328. https://scholarship.claremont.edu/jhm/vol8/iss1/14/

Poonen B. (2024). *Practical suggestions for mathematical writing.* MIT. https://math.mit.edu/ poonen/papers/writing.pdf

Wilkes G. (2023). *A brief guide to mathematical writing.* University of Cambridge. https://www.dpmms.cam.ac.uk/ grw46/Writing Guide.pdf