Advice for giving seminar talks

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Apart from the new mathematics you learn, giving a seminar talk is a great opportunity to practice important life skills: researching a topic in detail, designing and giving a public presentation, and answering live questions. Below I collect several tips and techniques that I found helpful for preparing such talks. All of these are just suggestions, and different things work for different people. You can have a look and get some inspiration, but you shouldn't feel like you have to follow every point!

1 Most important points

- If there are any unclear points during the preparation of your talk (what to present, mathematical details, etc), you can always ask the organizer!
- One important resource in your talk is time. Think about how you can save time spent on boring things (e.g. by not writing full sentences, drawing a complicated picture on the board before the talk) so that you have more for the interesting stuff!
- Another important resource is the motivation of your audience. Instead of giving a sequence of definitions, lemmas and theorems, try to tell them why a concept or result is interesting, and where your talk is going, to avoid losing their attention.
- When you give a talk about some written reference material (in book, paper, etc), it is *always* necessary to fill in gaps in the argument, correct typos, or add more examples to help the audience understand. If you just copy one to one from the reference, without additional explanations, the audience will probably not be able to follow (and could anyway just have read the book instead of coming to your talk!).
- Being nervous before your talk is completely normal, and happens to everyone, even experts who have given hundreds of talks! It can help to practice the talk in front of some friends beforehand, and to take some deep breaths in the minutes before your talk starts.
- In other talks or lectures you attend, take note which things work or don't work. You can learn a lot about giving talks like this! In particular, giving feedback after other students' talks also helps the person giving feedback.

2 Preparation

- Find out (or decide!) what topics and material your talk should cover.
  - In some seminars, there will be an outline prepared by the organizer. Here, if the talks of the seminar build on each other, make sure that you treat all concepts and results from your assigned topic that are needed later. If you are unsure, check with the organizer!
  - If you have some freedom what you want to talk about, decide which are the most important results and proofs that you want to show. Then, plan which prerequisites you need to introduce to get to these interesting results. For now, try to avoid adding material that is not strictly necessary – once you know how long the core of your talk needs, it's still possible to add side remarks and additional results.
- Try to understand the material as thoroughly as possible! Ideally, you should be able to explain every single explanation and implication. If any step in a proof is mysterious to you, it will also be mysterious to your audience!
- About sources:
  - It's ok to use Wikipedia and Youtube to get a first idea about a topic!
  - Even very serious and important-looking books or papers can have mistakes and typos! If something doesn't make sense to you, you can always ask the organizer.
- It's best to finish the preparation of the talk a bit in advance, put it to the side for two days, and then revisit and revise it with fresh eyes.

3 Time management

Since the time that you have for your talk is fixed, it is a precious resource that you should use wisely. Try to maximize the value that your audience gets from the talk, given the amount of minutes that is available to you.

- You lose time by
  - going slowly in parts of the talk that are easy to understand (e.g. repeating a definition with minor modifications, drawing a complicated picture to illustrate a simple point),
  - explaining (boring) things that are ultimately not needed (e.g. explaining the definition of a hypergraph, in a talk about graphs)
- You can save time by
  - avoiding to write full sentences

  - presenting a reminder from last time, elaborate pictures or long calculations by preparing them on a separate board, using a beamer or giving the audience members a handout
  - giving an explanation or a side remark verbally, instead of writing them down

- You can get a feeling for the timing of your talk by giving a practice talk before. If it's too long, think about which parts to shorten or to cut. If it's too short, think about which additional examples, results or topics can be added.

- A great way to finish your talk on time is to design the last part of your talk in a flexible way, so that some parts can be cut (e.g. extra examples, a technical proof) or some parts can be added (e.g. an outlook on further topics, a variant of the main theorem) depending on the time you have left.

- If in doubt: very few participants of seminar talks were ever annoyed because the talk was too short!

4 Motivation management

A second resource which is important to manage is the motivation of your audience. In general, the people attending your presentation will start out being motivated to listen to you and to follow what you say. But it's very easy to lose them, basically every time that they either become confused, or bored.

- You lose audience motivation by
  - saying things that the audience does not understand
  - introducing a new concept without explaining where it comes from and why it is useful:

    Chapter 2 : Vector spaces
    Def
    A vector space over a field k is a tuple $(V, +, \cdot)$ of an abelian group $(V, +)$ and an operation $\cdot : k \times V \to V$ satisfying ...
  - spending too much time on things that are boring for the audience, e.g. because they already know them well

- You can increase motivation (or avoid losing it) by
  - explaining the intuition behind a concept or result, before giving the formal statement
  - connecting the presented material to things that were treated earlier or giving an outlook where the material will be used later

– saying (not writing!) something reassuring before introducing something genuinely complicated, e.g. as follows:

> The following diagram looks scary when you first see it. But don't worry, I will write it down and then we go through all of the parts slowly.

Here is a sketch how this could look in practice, for the example of vector spaces we saw earlier. Most of the text below should only be said verbally, with the most important keywords written on the board/slide:

> **Chapter 2 : Vector spaces**
> In the previous chapter, we talked about abelian groups $(G, +)$. These are collections of objects such that for $g, h \in G$ we have a well-defined sum $g + h$, which behaves like we expect. One example is the group $G = \mathbb{R}^3$ of vectors in three-dimensional Euclidean space. However, for such vectors $v \in \mathbb{R}^3$, there is another operation that we can perform: we can scale it by some number $\lambda \in \mathbb{R}$ and obtain $\lambda \cdot v \in \mathbb{R}$. These operations work well with each other, and for example satisfy distributivity:
> $$\lambda \cdot (v + w) = \lambda \cdot v + \lambda \cdot w \,.$$
> In the current chapter, we introduce the abstract concept of a vector space. Similar to the case of abelian groups, this is a collection of elements (called "vectors") which we can add, and scale by some numbers (which in general are elements of some field k). This generalizes the story for $\mathbb{R}^3$, and is useful e.g. for discussing vectors with more than three entries.
> **Def**
> A vector space over a field k is a tuple $(V, +, \cdot)$ of an abelian group $(V, +)$ and an operation $\cdot : k \times V \to V$ satisfying ...

- If your talk has multiple parts which are logically somewhat independent, you can notify your audience when a new part begins, allowing them to get back into the talk even if they drifted off before.

> Now if the first part of the talk was too technical, and you noticed your eyes glazing over – sorry for that! But now is your chance to get back on track, because in the second part, we'll be discussing something new: ...

5 Concrete techniques

Here is a collection of some tools that are useful to help your audience understand and follow the talk. One general remark here is that it your talk is based on some book or paper, the presentation there will typically be very short and condensed, compared to what you should aim for in the talk. In mathematical writing, one typically assumes that the reader

a) knows everything that came before (because otherwise they can look it up),

b) has time to think about each step of an argument if somethings is not clear right away.

But a talk is live, and so both of these don't apply! Thus one of the main tasks for you as the speaker is to help the audience by adding various details, reminders and extra examples.

- Recall definitions and results in a verbal side remark (or with a small written note in a different color), in particular if they have only been introduced in an earlier part of your talk.

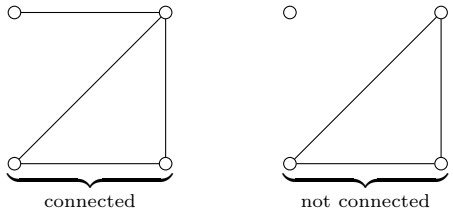
  Prop For a continuous function $f : X \to Y$, the inverse image $f^{-1}(V)$ of a closed set $V \subseteq Y$ under f is closed.
  Proof $V \subseteq Y$ closed $\implies$ $Y \setminus V \subseteq Y$ open
  (in words: *"Recall that by definition the set V is closed if and only if its complement $Y \setminus V$ is open"*)
  Then

$$f^{-1}(V) = X \setminus \underbrace{f^{-1}(\underbrace{Y \setminus V}_{\text{open}})}_{\substack{\text{open, since} \\ f \text{ continuous}}} \text{ is closed.}$$

  (in words: *"For the first equality, we use that any element $x \in X$ either maps to V under f, or to the complement $Y \setminus V$. Thus X is the disjoint union of $f^{-1}(V)$ and $f^{-1}(Y \setminus V)$, and so these two sets are complements. But now we are done: to show that $f^{-1}(V)$ is closed, it suffices to show that its complement $f^{-1}(Y \setminus V)$ is open. This then follows from the definition of a continuous function: the preimage of the open set $Y \setminus V$ is indeed open."*)

- When you give a new definition, you can help the audience to digest it by giving some examples (and maybe some non-examples!).

  Def A graph G is connected if for any two vertices $v, w \in G$ there is a path from v to w.
  Exa



  If the source material that you use does not provide such an example, try to add one yourself.

- When you present a mathematical result, it's often good to give a (simple) application right away. If it is a theorem with many assumptions, it can also help to discuss whether they are necessary, or what precisely goes wrong when you omit them.

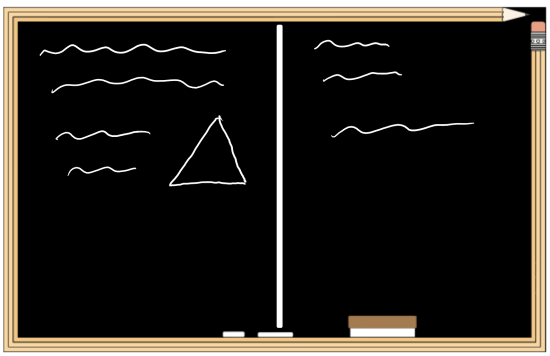
  Thm Any non-constant polynomial f with complex coefficients has at least one complex zero.
  Exa/Rmk
  $f = x^2 - x - i + 1$ is non-constant $\implies$ f has a zero (e.g. $x = -i$)
  The theorem is false if we omit the assumption that f is non-constant (e.g. $f = 1$ has no zero), or if we replace the complex numbers by the real numbers (e.g. $f = x^2 + 1$ has real coefficients, but no real zero).

6 Practical matters

Get familiar with the presentation system that you intend to use, and don't hesitate to practice a bit in the room during a time where it is not used.

6.1 Blackboard tips

- To check the size of your handwriting, you can put the title of your talk on the board before the start, and then walk to the back of the lecture hall to see if it is big enough to read from there.
- I recommend preparing one set of notes containing precisely what you want to write on the board. Going into the talk with 20 pages of handwritten summaries and a copy of the book with pencil-remarks on the margin is a recipe for chaos ...
- Consider separating the board into two or three parts, depending on how much vertical space you need.



- Writing whole sentences on the board can be quite slow, and can quickly get boring for your audience. Consider using abbreviations or avoiding filler words, to speed things up, i.e. instead of

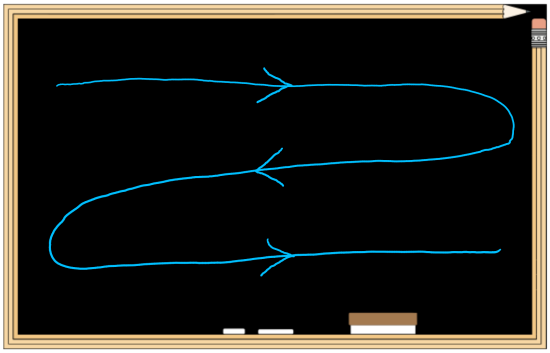
  Definition
  Let G be a connected graph and let $H \subseteq G$ be a subgraph. ...

  it's ok if you only write

  Def
  Let G : connected graph, $H \subseteq G$: subgraph. ...

- Breaking chalk in half and holding it at a 45 degree angle against the board while writing avoids making a "squeaking" noise.

- If you use the wet wiping system:
  - Don't hesitate to make the sponge-part really wet.
  - Always remove the water using the wiper.
  - A very efficient pattern for the wet and dry wiping is to clean the whole length of the board at once, as follows:



  - Before erasing, think about which parts of your notes you want to keep on the board (e.g. a definition that is used later), and try to avoid removing things that you have only written recently.

6.2 Beamer/Digital whiteboard tips

While it's not the most used format for mathematical seminar talks, there are some topics for which a slide presentation or a digital whiteboard are a good choice. There is a lot of advice online how to prepare such talks (and the technical details depend on the specific system you use). Below I just mention the most important points.

- The main advantage of presenting your talk with a beamer is that you can go fast during boring or easy parts of the talk. The main disadvantage is that you can also go fast during interesting or difficult parts! A one-hour beamer presentation consisting of 50 densely written slides is a recipe for desaster!
- A second difficulty is that your audience won't be able to see previous slides (or parts of the whiteboard). Thus if you use something from earlier in the talk, consider going back to the corresponding part, or repeating the previous result in a small box on the slide where it is used.
- Ideally, you should make your slides available to the other participants by sending them to the organizer before the seminar, so they can be sent around.
- Writing slides by hand will be quicker than using LaTeX. Typically you should avoid mixing the two formats.

- On the technical side, remember Murphy's Law:

  > Anything that can go wrong will go wrong.

  Thus it's a good idea to plan some contingencies (have a pdf-version of your prepared whiteboards, have all the files on a USB-stick and ask a friend to bring a second laptop etc).

7 Question management

In many seminars I organized, there were unfortunately very few questions from students in the audience. That's too bad, because questions can help resolve confusion (for everyone), and also a seminar is a great opportunity for the speaker to practice answering questions!

- As a speaker, once you finish your preparation, try to think of some questions that the audience might ask, and practice your answers (out loud at best!). This way you don't just increase your confidence, but you also see which parts of your talk might be expanded to be more clear.

- It's also allowed for the speaker to ask questions to the audience! On the one hand, this can be questions about the material, to make the talk a bit more interactive.

  > Can someone give an example of a Platonic solid?

  Here it's good to stick with simple questions, and to have a plan for the case if no one answers.
  On the other hand, it's good to occasionally ask if the audience has questions. In my experience, just asking "Any questions?" rarely leads to a reply. Sometimes it can help to be a bit more specific:

  > Are all the steps of the proof clear, or should I give some more details for one of them?

- If you get a question which you cannot answer immediately:
  - It's ok to take a few seconds to think about it – probably the audience is happy for the break anyway.
  - To get even more time, you can use one of the following maneuvers:
    * Thanks for the question!
    * That's a very good point/question/comment!
    * Sorry, can you say that again?
    * Mmh, I am not sure right now, but I will think about it (or look it up) during the break/until next time, and I'll get back to you.
    * Maybe we can discuss this after the talk?

– You can also try to pass the question on to the organizer of the seminar, a speaker who spoke about a related topic before, or even the entire audience.

8 Stress management

To quote from the paper "How to give a good research talk" by Jones, Hughes and Launchbury:

> *If you don't feel nervous before giving a talk, especially to a large or unfamiliar audience, you are a most unusual person. Between us we have given hundreds of talks, but the feeling that your legs just won't support you when you stand up in front of all those people never goes away.*

Here are a few things that helped me in the past:

- Remember that the audience is on your side, and each of them is just as nervous before their own talk.
- Giving a test talk, ideally with a small audience of friends, is a great way to gain practice and confidence for the actual talk. Since the stage fright often calms down after the first few minutes, you can in particular try to practice the beginning of your talk until you can give it in your sleep.
- There are various techniques like progressive muscle relaxation or deep breathing that can help you reduce stress.

9 Further guides and resources

- Der goldene Weg zum perfekten Seminarvortrag
- Wie gestalte ich einen Seminarvortrag?
- 50 tips for preparing and giving math talks
- How to give a good research talk