MATH 8001
25 October 2013

Writing and delivering lectures

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Writing and delivering lectures to a large class of precalculus or calculus students for the first time

We'll save these discussions for later:
- teaching a summer course (which includes main responsibility for presenting the material)
- giving general math talks

Assignments

due Friday 8 November: observation notes
due Friday 15 November: lecture notes, described below

Any questions about the peer observations, mid-semester student feedback, or faculty observations?

Any issues arising in your current teaching?

Plan for today:

- Crowd control

- Content considerations
  - preparation
  - organization
  - theory/examples
  - pacing

Golden rule: Be yourself.

Students keenly detect discomfort.

On the other hand, they recognize when you are trying out ideas for the sake of improving the class and their learning.

First day

- It is important to create a good first impression and set a business-like tone.

- It is easier to relax a business-like environment later than it is to rein in an unruly environment.

- For the beginning (only) of the first day, write out a script. Then it will be easier to talk extemporaneously when you are in the flow of the mathematics.

Crowd control

1. “Own the room”. Walk to the back before class.

Fill the room with your voice. If necessary, use a microphone. Imagine speaking with a person in the back row.

Crowd control

2. Be prompt so that the students will too.

- Start at the official time everyday, using a room clock or a laptop clock. There are 15 minutes between classes, so there should be plenty of time to prepare technology and boards.

- Ask them to inform you before class if they intend to leave early, and ask them to sit in the back row.

- If you are in the middle of something at the end of the time (something you should try not to do), say "I need one minute to finish this idea" or "I will return to this example at the beginning of next time" (and then do it).

Crowd control

3. When students are anonymous, they are less likely to feel personal responsibility for their behavior.

- Print out the class roster with photos.

- Choose a handful to names to call at the beginning of class.

- Urge them to visit your office hour, if only briefly.

- Stop by your students' discussion sections.

- Chat with students before class.

Crowd control

4. What to do about electronic distractions?

- “If you can’t beat ’em, join ’em.”

- I find that meaningful eye contact is most effective in curbing disruptive behavior; students do not like to be singled out in class.

Crowd control

5. Eye contact

- Lack of eye contact indicates nervousness, whether you are or not.

- Make eye contact with people in the back row – everyone will see that you are making eye contact with someone. Do not stare at the ceiling.

- These eye contact breaks allow you to check how students are keeping up with your pace.

Content considerations

1. PREPARE. Make it worth the students' time to attend.

- In particular, try not to work out solutions for the first time on the spot. The most common loss of time and loss of focus of students is due to trying to fix solutions gone awry. If you do get lost – and it will happen – say that you will move on and provide that solution later.

Content considerations

2. I recommend using slides from a laptop or on an overhead projector.

- Not complete details (the pace will be too fast for note-takers)

- Instead, use slides to give an outline and statements of definitions, theorems, examples, and exercises. Write details on the board.

Content considerations

3. Write with the large chalk (if in a room with chalkboards). Bring this with you every day – there is a supply in the mail room. Or, bring fresh dry-erase markers every day.

- Walk to the back of the room to check that your writing is legible. Also, this breaks the barrier with the students.

- Include only the most important information in a graph, and draw graphs as large as possible. Also, don't update a graph by erasing and adding new information. (Another case: row reductions)

Content considerations

4. Asking questions

- Questions like "Does everyone understand?" don't elicit responses, and easy questions that require numerical answers don't either, and can be viewed as insulting.

- Better to ask PROCESS questions like "What do I do now?" or "Why wouldn't approach x work here?"

- Be willing to wait what seems like a long time for someone to volunteer the answer. This can be a good time to walk up the aisles. It also gives careful note takers time to catch up.

Content considerations

5. Soliciting questions

- If you ask, "Does anyone have any questions?", wait for responses.

- Walk to the person asking the question.

- Most important: REPEAT THE QUESTION for the whole audience to hear (paraphrasing if necessary to clarify or focus the question).

- Be willing to tell a student "That's an important question, but it is too [...] to spend time on during lecture. I will be happy to answer your question after class."

Content considerations

6. Change the pace and activities to improve attention

- One suggestion: halfway through class, give a short exercise, and ask students to compare solutions with their neighbors.

- Asking a student to come to the board to give a solution is rarely effective, but it can be useful (once) to demonstrate that you welcome students' input. Only after a student volunteers an answer aloud. I don't recommend cold-calling students in lectures (or anywhere, really).

Content considerations

7. We overestimate students' tolerance for lists of theorems, mathematical formalism, $\forall$, $\exists$, $\in$, etc.

Content considerations

8. Look for one take-home idea to emphasize at the beginning and end.

Students want to know, practically and mathematically, "Why is this important for me to know?"

Content considerations

9. Near the end of the period, it is better to summarize than to start a new idea or example that you can't finish.

Prepare several potential "bail-out" locations in your lecture.

Content considerations

10. Organization: "top to bottom" or "bottom to top"?

Start with examples to motivate general idea.

Showing applications of a theorem before providing a justification for the theorem.

Content considerations

11. Help students who are taking notes and not processing any information: give clear markers for the beginning and end of examples, use boxes for important ideas, extended pauses to make transitions.

Content considerations

12. Ask yourself, how am I creating an experience that a video or a textbook can't provide?

- by being receptive to questions
- by modeling how you think about the mathematics informally
- by inviting them to engage, with exercises for example

Equivalent forms of the Archimedean Property

Theorem

The following statements are equivalent:

1. *(Archimedean property)* $\mathbb{N}$ *is unbounded above in* $\mathbb{R}$.
2. $\forall z \in \mathbb{R}, \exists n \in \mathbb{N} \ni n > z$.
3. $\forall x > 0, \forall y \in \mathbb{R}, \exists n \in \mathbb{N} \ni nx > y$.
4. $\forall x > 0, \exists n \in \mathbb{N} \ni 0 < 1/n < x$.

Notes

- First let us visualize the meaning of each statement:
  - 3 = Tiny steps
  - 4 = Capture the flag
- Then, prove $1 \Rightarrow 2 \Rightarrow 3 \Rightarrow 4 \Rightarrow 1$. (With 4 implications, we actually prove 12.)

Assignment, due Friday 15 November

Write a set of lecture notes for one 50-minute lecture on a text-book section that your current course will be covering sometime in the next three weeks.

Write notes that you would take to give the lecture: in other words, include cues for yourself.

Pay close attention to length – mark where you are likely to finish.

Include at least one "motivating example" – an example after which a general idea appears.