

Thoughts about aspects of in-class teaching

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For a while it has been popular for people to do research on the most effective way to teach at the university level, generally, and to teach physics and astronomy in particular. This has led to a number of interesting ideas but, in my opinion, has also led to inappropriate dogmatism in telling teachers that they *must* teach using a particular style. I find it odd that it is fully accepted that the optimal learning style can vary from one student to the next, but it is considered fine to tell teachers that there is one true path.

My opinion is that there *are* some requirements for teaching, but that beyond those I would encourage you to be open-minded about different teaching approaches and to, through experience, determine what style works best for you. Whatever your style is, it will not be perfect for every student, but you can and should, throughout your career, be alert to ways that you can improve and diversify your teaching methods. It is also important to keep in mind that you have limited time with your students; their learning is primarily their responsibility, and so you can only provide them with opportunities and do your best to motivate them to take advantage of those opportunities.

With that, I would like to distinguish what I consider requirements, from what I think are a smorgasbord of possibilities to consider in quantitative university courses in math, physics, and astronomy (and maybe others).

Requirements

1. **You must be clear in your expectations.** Even though we hope that our students focus primarily on understanding the material (and some will fall into that category), you need to let them know what they need to do to obtain good grades. That will make them feel more secure in the course and thus open them up more to learning.
2. **You must be organized.** For any given topic, you should decide on the key points and the interesting sidelines, and should endeavor to make the course flow in a logical manner. You should also, for example, return graded assignments fairly promptly, to provide feedback, and if you make a commitment to the students you need to follow through.
3. **You must be enthusiastic about the subject.** Why should the students care if you don't? This doesn't mean you have to be bouncing up and down; it's more that if you communicate a love of the subject then the students will pick up on that. You also should make clear to the students why the subject is important, to them as well as to you.
4. **You must be informed about the subject.** You should be well prepared; it's proper and can even be beneficial if you admit sometimes that you don't know something, but if it happens too often then the students are shortchanged and also get the message that you don't care enough to educate yourself.

5. **You must demonstrate respect for the students.** Many, probably most, students are somewhat reluctant to interact in class or to come for help. You should be encouraging when they interact and take their questions seriously. Anyone who has taught realizes that students will ask questions after you've just explained something with unambiguous clarity, but you still need to address those questions positively. Otherwise, it chills the class. Another way to demonstrate respect is to show up on time; your late arrival sends the message that you have better things to do. Overall, you need to make clear with your actions that you care about the students and their learning.

This does not deal with various situations that will arise (what do you do when a student cheats or is disruptive, how do you adjust if the level of your course becomes obviously too high or too low, etc.), but that's not the point of this document.

Now let's talk about some optional things to try. Again, I recommend that you be open-minded and see what works for you.

Various things to try

1. **Lecturing.** This requires some explanation, because practically every talk I've heard about teaching says at some point that lecturing is terrible. Sometimes it becomes clear that what they have in mind is a caricature of lectures in which the speaker expects complete silence and rapt attention with no two-way interaction. If that's *all* you do when you lecture, then indeed that isn't great. But you can be much more engaging. You can (and in my opinion should) ask the students questions, and should encourage them to ask you questions, and whenever they ask or answer you can be encouraging in your response. You will also usually find that some students are eager to answer and others are not; to encourage broader participation you can ask for a contribution from someone who hasn't yet had the chance to speak, and kindly indicate to a frequent participator that you appreciate their thoughts but would like to spread around the contributions. You can also consider asking a question such as "did I explain that clearly?" instead of "any questions?", because the former approach removes the burden from the students if they didn't understand. You can also ask whether a student has a different way to explain a given concept (if you're confident that this won't lead to rambling). Also, of course, you should be receptive to questions at other times, whether those are just after class or during your office hour.
2. **Flavor.** You don't have to be dry in your presentations. In a lecture you can tell stories about the principals in a given subject, or your own experiences if they are relevant. You can quote poetry, play a musical instrument, juggle, discuss your travels to relevant places (e.g., Florence if you're talking about Galileo), set up a "quiz show" in your class and give candy as prizes, or other things. If you're having fun, your students have a better chance too!
3. **Humor.** Typical class periods are long enough that students will lose focus. One way to bring them back is to inject humor at appropriate times. As always, it is important for that

humor to be relevant to the topic, for example, a funny story related to the subject or people in question. One thing to avoid is pausing after saying something funny; just keep talking, and if the students laugh then that's the point where you can smile with them.

4. **Breaks for discussion.** Regardless of how engaging you are a speaker, there is a risk that students will turn off during a class unless they have something that they can do. You could, for example, decide on a topic per class that is especially important, and have the students debate a question or solve a problem in class or something like that. In such a case, as in answers to your questions, it is useful to encourage creative thinking. Even if students come up with a clearly wrong answer, you can usually find a way to reward their creativity. The destination is important, but so is the journey.
5. **Required reading and reaction before class.** For any class the students will benefit from reading and preparing in advance. In a big class you could encourage this by having a short quiz on the reading at the beginning of the class. In a small class (say, fewer than 20 students) you could be more involved by requiring that the students send you questions about the material, and then adjusting your presentation accordingly. Instead of required reading, some instructors will pre-record a short summary of the material, but the same principle applies.
6. **Demonstrations.** A good demo can perk up a class and improve understanding of a topic. Some are canned demos (physics departments often have well-tested demonstrations), but if you make it a demo that is personal and fun/funny that can grab attention even more. Maybe you have special talents that you can turn into a demo.
7. **Guest lecturers.** Sometimes it can be a fun change of pace to bring someone else in who has a different perspective, or special expertise. For example, when I taught a Life in the Universe course, for one class I brought in a geology colleague who had a great set of fossils to pass around.
8. **Field trips.** In some circumstances (small class size, course of a particular type) you might consider taking your class to a special location. In astronomy, examples could be night observing, a visit to NASA, or something else.
9. **Positive examples of historical/current figures from many different groups.** Role models matter. You are who you are, but if throughout the course you bring up relevant and positive examples of people from different cultures and groups, that will encourage a wide variety of students.
10. **Hints from colleagues.** Especially if you're teaching a class for the first time, it can be valuable to get suggestions from those who did it before. You could sit in on their class in a previous term, or you could ask them directly what they would suggest for a given subject or situation. The final decision is up to you, but particularly if your colleague teaches the way that you do or would like to, this is a great way to get ideas.

11. **Extra material.** You don't want to be caught short and thus have dead time or classes that end early. Thus it is a good idea to prepare extra material that you can add if necessary, and that isn't essential if you do use your allotted time.

Again, these are merely suggestions for consideration. Some people are not natural joke-tellers, for example, so it might not be easy to pull off humor. And it takes experience to run group discussions or to solicit interactions (for example, it's a good idea to wait for a response rather than jumping in with the answer). But as indicated above, if you have a thought about a style you like, I encourage you to attend classes taught by people who have that style, or for that matter who have other styles, so that you can see how they educate the students.

You should also recognize that teaching involves compromises. If you spend more time on a given topic then you spend less time on other topics. This means that you need to make a clear decision about which subjects should be emphasized strongly. For those subjects, you can use extra time for demonstrations or discussion or whatever. Much of the research on techniques to improve understanding basically involves spending more than the usual amount time on a topic and then testing on that topic; it is expected that the students would do better than normal on *that topic*, but it does mean that they'll understand other aspects of the course more poorly. However, if you feel that some particular lesson is really important, you can make that clear-eyed compromise.