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Pedagogical View

Teaching means to facilitate learning. This includes learning facts, skills and a certain culture. Clearly, these aspects differ from scientific field to field and reflect both a broad cross-section of the studied field as well as the intended occupation of the graduates, a university degree is neither an ivory tower nor a vocational training. In the case of a physics degree, I would consider it a rule of thumb to aim to educate good potential PhD students, but this is of course different when teaching engineering or medical students. Many of my thoughts on the matter were formed when I re-developed and taught the “Quantum Physics” course at the University of Technology in Sydney and have been refined since then.

In mathematics and physics, the facts are usually easiest to define and include theorems, qualitative and mathematical descriptions of fields of physics (so-called laws of nature) and common explanations for physical phenomena. Facts are mostly taught in lectures although books or other media such as videos can easily be a adequate substitute depending on the student's personality. Therefore, I am against mandatory attendance of lectures. Students should be self-sufficient enough to recognize whether they benefit from them or certainly must gain that level of self-sufficiency. Facts are easy to list in lectures and easy to “measure” in written exams, which often makes them the focus of teaching, at least for central administrations. However, they are of limited use without the skills and culture described below.

The skills that a student should learn are generally harder to define. I would define “skill”' as experience in the tasks and operations that are common in the field of study. For a mathematician, this includes deriving expressions and most importantly proving theorems. For a physicist, this includes formulating and solving mathematical models for physical processes (especially finding and applying appropriate approximations) and designing and performing experiments. For every scientists, it includes communicating ones findings to a group of peers. Like an metalworking apprentice must hold a file themselves in order to learn the technique of filing, students must practice these operations in order to obtain some routine. This cannot be taught in lectures, but must be practiced in lab courses and
homework (ideally in groups), and presented in tutorial classes. The latter can serve to measure progress and also prevents to a certain degree that students freeload in their groups, but practicing to communicate is also a goal in itself. In addition to their obvious role as practice, exercises should ideally also have a didactic point (for example students can practice the motions of wave-function quantum mechanics by finding the first three eigenstates of the harmonic oscillator, which at the same time illustrates how nightmarish wave-function-based quantum mechanics can be, motivating the more abstract operator algebra). Lab courses, problem classes and seminars should be mandatory.

Finally, students should also learn the scientific culture, which means the ability and habit to collaborate, to exchange thought and convince others using logic instead of persuasion (überzeugen, nicht überreden), to disclose all relevant sources to ones work, to be aware of one's bias and try to minimize this effect. This usually does not explicitly appear in the curricula of courses and might not even be mentioned in description of a program. As a result, it might be overlooked, especially by central administrations, but it is crucial and should be an implicit goal of every interaction with a student. In lectures, facts should not be simply stated or “explained” using incorrect analogies or vague motivations, but demonstrated (in theory lectures by showing derivations or proofs, in experimental lectures by performing live experiments). The sources of teaching materials should be disclosed, students should be encouraged to work in groups and presentations in tutorials and seminars should emphasize logic and and clear communication, not marketing. Finally, students should occasionally be given tasks where failure is very possible (without serious repercussions, of course) in order to demonstrate how easily one is led astray by fallacies and bias or how much care is actually required in research. All this is in conflict with teaching facts and skills as efficiently as possible and a compromise must be found.

Teaching Experience

uring my PhD and earlier postdocs, I ran tutorials as a teaching assistant, organized tutorials including setting homework problem sheets and exams and stepped in for my supervisors on about a dozen occasions (typically 90 minutes each, about half in English, the rest in German), 3 of which I independently prepared on a subtopic within the course “Boundary value problems” held for 5th semester mathematics students at the University of Technology Sydney.

In late 2016, I worked for one semester as a lecturer at the University of Technology Sydney, where I was tasked with every aspect of the course “Quantum Physics” (60 applied physics students in 5th semester, 11 weeks of 90 min lecture plus 90 min tutorial). This included taking on the role of course coordinator, completely re-developing the curriculum (partially because of school restructuring), giving the lectures, setting the problems, running one of the two tutorials, setting and marking the assignments and written exams and conducting a handful oral exams. This experience was quite formative for my development as a teacher.

Since fall 2017, I have been teaching at SDU almost every semester one mandatory course for students of physics and technology (5 ECTS) and have adapted my style to the expectations of the department and the students mostly guided through the course evaluation procedure. The course taught have been the pre-existing course “Mathematical Analysis” for 3rd semester Bachelor students of physics and technology and the course “Computational Physics” for 3rd semester Master students of physics and technology, which I developed from scratch.

The list of courses independently taught by myself in chronological order:
- fall 2016: “Quantum Physics” in Sydney (approx. 5 ECTS)
- fall 2017: “Mathematical Analysis” at SDU (5 ECTS)
- fall 2018: “Mathematical Analysis” at SDU (5 ECTS)
- spring 2019: “Computational Physics” at SDU (5 ECTS)
- fall 2019: “Mathematical Analysis” at SDU (5 ECTS)
- spring 2020: “Computational Physics” at SDU (5 ECTS)

Finally, I have been engaged in the supervision of a large number of undergraduate and postgraduate thesis students including the co-supervision of 6 PhD students; so far I have not been permitted formal supervision of doctorate students.

Formal Pedagogical Training

To date I have not received formal pedagogic education, but instead have relied on mentoring from experienced colleagues, which includes both my immediate supervisors as well as actively seeking advice from faculty members with a good reputation regarding teaching. I will commence formal pedagogical training soon.

Other Teaching-Related Activities

I am currently in the process of developing a new elective course “Quantum Optics” together with some colleagues at SDU aimed at Master level and PhD students of physics and technology and related fields. This work is still in the early stages. Furthermore, I am in the process of organizing an inter-disciplinary weekly seminar open to all interested students, PhD students and postgraduates from SDU on topics of Optics. This development has proceeded quite far and the seminar will start as soon as external factors (e.g. the COVID-19 pandemic) permit.
I have been engaged in disseminating science to a broader public by developing an exhibit for a German museum of technology and by engaging in the “Long Night of Science” in Berlin.