Teaching Statement

Anton Nedelin

During my graduate studies and postdoctoral positions I have gained plenty of teaching experience at both undergraduate and graduate levels. In total I have taught around 350 academic hours. In most of the courses I served as teaching assistant (TA) and was giving tutorials to the students. However in my last year of PhD studies I designed from scratch and taught graduate course "Symmetry in Physics" at Uppsala University. Later in University of Milan-Bicocca I also designed and taught lectures for the half of the graduate course "Introduction to Conformal Field Theories". I also have experience in supervision of undergraduate students. In Uppsala University during the last year of my PhD I successfully supervised bachelor theses of two physics and one engineering physics student. All this rich experience allowed me to form my own vision of teaching. Below I summarize main principles which form the basis of this vision.

Learning physics, as any other subject, consists of two parts. First stage in learning is collecting and understanding relevant facts and core ideas in the subject. However real learning comes in the second stage when student tries to do something on his own: solve problem, do experiment, actively discuss ideas. This second part is the most important one and it plays central role in my teaching approach. I am always trying to structure my lectures so that by the end of each class students can solve problem on the topic of lecture. For this purpose I am trying not only to give main ideas and explain methodology but also to work out details with as much precision and clarity as possible. Often lecturers concentrate on presenting core ideas in a most entertaining way omitting details. As a student I was excited by such approach during the lectures but felt frustrated afterwards since I did not feel I learned enough to do something on my own. At the same time after lectures that thoroughly go through various subtle details I felt that I have knowledge deep enough to solve problem and to discuss subject of lecture with fellow students. This feeling was giving me high satisfaction and strong motivation to study. In my teaching I want my students to have the same feeling after the class.

However such approach to lectures has its own negative sides. The most significant one is the danger of loosing students attention due to the complexity of the lecture. To avoid this it is highly important to actively involve students into the learning process. In my teaching practice I use several tricks to achieve this goal. In the beginning of each lecture I am giving out short questions that students should answer anonymously in several minutes. Usually these are questions that can be answered without calculation and preferably those for which everyday life intuition suggests wrong answer. The purpose of this is to make students think about the topic of the lecture from it's beginning and to get them interested. Such practise in my experience was particularly successful in the courses of Quantum Mechanics and Special Relativity. Both these subjects are full of paradoxes that can be used as the basis for the questions with counterintuitive answers. Then during the lecture I am giving the answer to the question with detailed mathematical explanation. Curiosity raised by the question in the beginning helps students to keep attention and they are able to appreciate the beauty of the mathematical proofs of counterintuitive phenomena of the nature. To me this beauty is the soul of physics and I try to transfer this view to students during my lectures.

Another way to involve students in the lecture is of course stimulating discussions in the class. For a good physicist asking right questions is as important as to be able to answer them. One of the goals of the education in natural sciences is to teach students how to ask questions. To achieve this goal I use two principles in my teaching. First of all I incorporate questions in the lecture so that the lecture looks like a series of questions and answers rather than a continuous story answering one global question. I ask to students to suggest next steps to go through in order to answer these questions. At first students are usually hesitating to answer. And here comes the second component, the healthy discussion environment in the class. Obviously to step over the hesitation student should feel that she/he will not be judged because of "stupid" questions or answers. I am trying my best to give students the feeling that when you are in the process of learning something it is fine to be wrong in both asking and answering. These practices in the end worked very well for me and by the end of the courses most of students in the class were not hesitating to answer my questions and often were asking relevant questions themselves.

Since the goal of my teaching is to make student to be able to solve problems and create something themselves I try to make them work outside the class on their own. The simplest thing to do in this direction is of course to give them homework. I prefer to give homework problem after each lecture instead of giving few but bigger problem sets during the course. It is a widespread problem that the students just listen to lectures and don't reflect on the course material unless they are given homework. But if homework is given once per month students start falling behind and often even stop understanding lecture material. Even a small weekly homework on the other hand helps students to keep track of the course and comprehend lectures. Another pedagogical practice that I incorporated in my teaching are the *collective problem solving sessions*. In 2014 when I was teaching courses "Quantum Physics" and "Special Relativity" I added several classes optional for the students. In these classes I divided students into groups of three or four and suggested the set of problems to solve actively discussing them inside the groups. These sessions gave students practice of thinking, solving problems and discussion. During the class I was going between groups of students discussing their thoughts about problems and pushing them in the right direction in case they were stuck. In the end of the class representative of each group was briefly presenting solution of one of the problems in front of everyone else. Students were very happy with their experience and results of exams showed effectiveness of this practice. In the future I plan to incorporate this activity into all of the courses I will be teaching.

Finally I always pay much attention to the students feedback. For this purpose after each lecture I ask students to fill short anonymous questionnaire in which they evaluate quality of the lecture and specify parts they did not understand well. This helps me to adjust material of the following lectures to fill gaps in students understanding.