Teaching Philosophy

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When I started to write this note, I first asked myself one "silly" question: Why do we need teaching? In other words, why not just let students learn by themselves? A straightforward answer is that we need to explain the knowledge in the textbook to the students. If this is the main purpose of teaching, it immediately implies that if a student is able to understand the knowledge on her own, then she need not attend the class. In my opinion, teaching should make more sense than merely passing on knowledge; even students who can learn by themselves can benefit from a good teacher.

Then what is a good teacher? To answer this question, I first state a general rule: HOW is always more important than WHAT. For teaching, specifically, how the knowledge is created is more important than what the knowledge is: how a theorem is proved is more important than what the theorem is; how the proof is puzzled out is more important than what the proof is; how the problem is formulated is more important than what the problem is. Unfortunately, people usually concentrate on WHAT rather than HOW. In my opinion, this is very dangerous and wasteful. To see why, let us check how the knowledge learned in class is used after students graduate. Most of them will find a job in a company and use the knowledge in applications, while a small group will find a job in a university or institute and use the knowledge in their research. Whatever job they take, the students will use the knowledge in a new environment: do a new project, prove a new theorem, consider a new problem, and so on. In this sense, they could never learn the "exact" knowledge they need in reality. If they just apply what they have learned mechanically, their conclusion must be contorted and unreliable. Given this fact, it is easy to see how wasteful it is to spend so much time in school learning something useless in one's future career. To apply the knowledge properly, we must know how it is created. Only if we know how it is created, we will know when it can be applied, how it can be applied, and most importantly, how to create new knowledge by ourselves. This world is changing rapidly, and new knowledge is created every day. If we cling to WHAT of this world and the new knowledge, then we will get tired and exhausted from chasing the changes arduously. If we know how this world is changed and how the new knowledge is created, we will understand what changed is only WHAT and HOW has never changed. In summary, a good teacher teaches students HOW instead of WHAT.

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However, it is much harder to teach HOW than teach WHAT. In fact, students are usually not prepared well even on WHAT. Also, HOW can only be taught based on WHAT. So I will first discuss "what" we should teach. Based on my experience, students tend to forget much of the knowledge the teacher taught after completing the course. So if we want the students to keep something in their mind, we need to help them keep the most important part. Which part is the most important, i.e., which part is most likely to be used in the future and helpful to learn HOW? The answer to this question depends on the research experience of the teacher, so, in my opinion, a good teacher must be a good researcher (the inverse may not be true). On the frontier of some topics, the answer may vary among researchers, while for many typical topics, there is a common sense among good researchers. For example, the dominated convergence theorem is the central theorem of real analysis, GMM is the central estimation method of modern econometrics, the separation theorem is the central theorem of convex analysis, the Neyman-Pearson lemma is the most important lemma in hypothesis testing, and so on. At this point, I want to emphasize again why we should study WHAT (or the existing knowledge) - it is because we want to learn HOW based on WHAT. It may seem a paradox that the purpose of learning WHAT is to discard (or transcend) it, but this indeed should be the ultimate meaning of any learning process.

To teach HOW, I found the following two steps are quite efficient. First, use a simple example to illustrate the essence of the problem we are studying. Usually, this example is easy to understand and the solution is straightforward, so it is likely to intrigue the students. Second, build intuition from this simple example and extend the intuition to the general problem. Students understand concrete and intuitive things better than abstract concepts or theorems. Intuition can also build an vivid image in their mind, which will last for a longer time in their memory. Student feedback from my teaching experience on these two steps are encouraging; see ratemyprofessors.com. A few examples of intuitions I used to explain some basic econometric concepts are provided as follows:

- Bayesian and frequentist confidence interval construction: These two methods can be described as two scenarios of butterfly catching - catching a moving butterfly using a fixed net vs. catching a fixed butterfly using a moving net.

- Ordinary least squares (OLS): Basically, the population version of the OLS is a "projection" in L^2 space, while the sample version is a "projection" in $\mathbb{R}^n$ space.

- Conditional expectation (CE): The CE with respect to different σ-algebras is like what we will see under different microscopes. A fine σ-algebra is like a high-definition TV, while a coarse σ-algebra is like a low-resolution YouTube movie.