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Resource: The Torch or the Firehose  
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## A Word About Pedagogy



There still remains the problem of how to present the material and explain it clearly. Here we are at the limits of what a little booklet can say. Still, even long-time teachers make such elementary errors of pedagogy that it might be worthwhile to talk a little about the subject from a practical viewpoint.

Three different approaches to classical psychology offer valuable insights that can be used in every class.

### Define the tasks

Behavioral psychology might urge you to think about what it is you want your students to be able to do. Differentiate all functions of a certain type? Check an answer by qualitative reasoning? Isolate and analyze the forces on a rigid body? Synthesize an organic molecule on paper? Trace the themes of a Bach fugue? These will require different approaches, but they are alike in this way: they are specific tasks that your students can aim at mastering. By contrast, the vaguely formulated tasks implied by enthusiastic lecturers and recitation teachers—understand the role of the mean value theorem in calculus theory, appreciate how Maxwell's equations summarize the laws of electricity and magnetism—leave students uneasy and asking about exams, to their teachers' irritation.

**Are we responsible for the laws of planetary motion?  
No, Kepler was.**

—from a physics class



### Explain your thought process

The introspective approach to pedagogy would suggest that you look inside yourself for clues to good teaching. Solve a problem and watch yourself do it. What guided your thought? How did you know to try what you tried? Tell your students.

### Thinking starts with a problem

Located somewhere between behaviorism and introspection, the school of gestalt psychology teaches that thinking starts with a problem, a difficulty, a contradiction. It sounds like a truism, yet is widely ignored in practice. Teachers say their aim is to get their students to think, yet in classroom after classroom they violate this psychological principle by giving the solution before there is any problem.

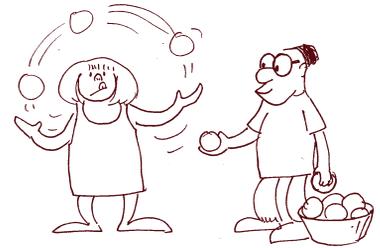
“Now we are going to study a new kind of integral, called the line integral. Here is the way it is defined...”

Sound familiar? Of course, the motivating problem must be an interesting one—that's where it helps to try to find things in the real world to serve as the problem source.

The above ideas barely scratch the surface of what psychology and research into learning has to contribute to our understanding of pedagogy. But we're after just a few basic principles that will be easy to remember and will help your teaching immediately. Here are three more that you'll find use for constantly.

### **Go by degrees from the easy to the hard**

Things can be hard because they are complex, requiring many steps and processes (like multiple integration in calculus), or because they involve subtle ideas (like the Coriolis force in mechanics). If you think the complex problem will be too hard, first give your students practice with simplified problems involving only a few of the steps. For subtle ideas, look for simpler analogies, allow a lot of time, and be patient.

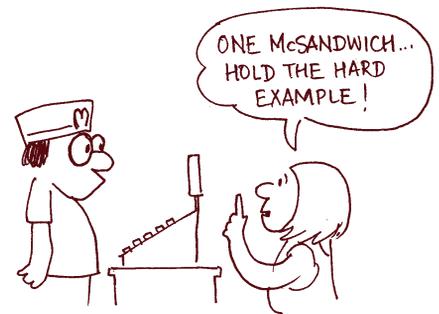


### **The sandwich method for general principles**

To present an abstract idea—a general formula, a general law, a theorem—a good way is to present in order:

- An easy example illustrating the principle
- The general statement and explanation of the principle
- A harder example using the principle

This corresponds to the way people think. It's much easier to understand an abstract idea if you can test it out on a simple example. Then once you've understood the principle, it's fun to see its application to a more complex example that was too difficult to handle before.



### **The bird's-eye view and review**

Often students can't follow an explanation because they can't tell where it is headed, what the ultimate goal is. You know, but they don't. So begin a complicated explanation by giving an overview of what it is you're going to do—the purpose, the general method, how long it will take, whatever. Some teachers like to write this outline on the board. When it's all over, turn back and survey the ground you've covered together, and congratulate them on having made it.

The other way—keeping the students in suspense so that the purpose of everything becomes clear only at the very end—may be a great way to tell a mystery story, but it's a bad, bad way to communicate complicated information. Give them instead right from the beginning the "picture on the box"—the picture on the jigsaw puzzle box that serves as a guide for how the pieces fit together.

**First I tell 'em what I'm gonna tell 'em, then I tell 'em, then I tell 'em what I told 'em.**