Methods: How it works

This is an experiment in pedagogy. I don't know if it will work. We start with the ends: make a list of 100 questions that students should be able to answer after taking an introductory class in materials science. Discard the lessons that explain the qualities of materials without some form of interaction. Encourage the students to make their own investigations and draw their own conclusions.

Questions are categorized into things that are well known (and can be presented), properties that may be calculated, and speculations.

The goal is to make the class self-generating: illustrations provide the foundation for speculation, calculators provide the tools, and speculation provides hypothesis that may be tested by experiment.

What do we gain by this process?

1. The students become engaged when they are answering their own questions
2. by designing their own experiments the students capture some of the excitement of learning somethign for the first time (rather than doing a tired, well-worn experiment)
3. They actually have the chance to discover something new
4. they learn how to formulate and conduct experiments
5. we use what we have--the resources are modest (call this *For a Poor Science*)
6. using language to reveal big ideas (rather than reducing the ideas themselves)

The questions range from *Why is the sky blue?* to *What makes glass brittle?* Ask a group of 25-30 students to select five questions from the 100 and/or write their own questions about common materials (glass, metal, wood, bone, etc.) This first assignment gives the students some skin in the game as they will be investigating materials that interest them and/or materials that are relevant to their metier.

Whenever possible we avoid textbooks and learn directly from the materials. We seek to learn from craftspeople who have spent a lifetime working with materials; from industrial processes to transform materials. These

The questions are refined and qualified by type: *illustration*, *calculation* and*speculation*. These definitions define specific tasks that will help explain what Each student will be responsible for answering these questions.

An *illustration* is a 5-10 minute presentation showing a material, a process or idea. Generally this is a short film or other presentation showing interaction with a material. Example: for the section on metals the student might bring in a video showing a blacksmith forging horseshoes.
A *calculation* is a resource that we will use to explore a material, process and/or idea. Specifically I would like you to make a reactive web page that calculates for you. *Speculation* is a hypothesis, an idea or position about a material that may be rendered into a*falsifiable statement.* The student's speculations will be the basis of the experiments that we conduct in class.

Now we put the questions on the calendar. I used **Kanban boards** **(https://en.wikipedia.org/wiki/Kanban_board)** to organize the questions under materials and then to schedule them.

The questions overlap in ways that suggest collaborations. Their work produces an understanding of materials from interaction with materials. They depend on one another's work to advance their own understanding. This raises the stakes for everyone in the class. The design of the course promotes engagement and collaboration.

We also recreate relevant debates in the sciences including *Aristotle vs. Democritus on the number of elements* and *light is a wave vs. light is a particle* . These debates help the students to imagine a time before our understanding about materials was fully codified.