Motivation

Our Students

1. Think about your experience of students in core physics. In general,
   a. are they motivated to learn physics?
   b. do they know why physics is required?
   c. do they believe that physics is relevant to their lives?

2. Why do you suppose students copy homework problem solutions from other students or internet sources? Likewise why do you suppose some students cheat on in-class quizzes, tests or exams?

3. Do you think your students are happy when class ends each day? Or do you think they feel that class time passes too quickly? Explain how you know and why suppose your students feel that way.

4. Do you think your students read the textbook (besides referring to the end-of-chapter problems)? If you suppose they don’t read it, why do you think they don’t? If they do read it, what do you suppose they get out of it?
Our Attitudes
1. Why do you suppose USNA requires core physics of every student?
2. Think beyond the confines of USNA and the Navy. Why should we teach physics, or any science, to non-majors? In other words, what is it that science (or physics in particular) has to offer?

Our Practices
Think about your experience of teaching core physics.

1. Do you motivate students? If so, how? If not, why not?
2. Do you expect your students to read the textbook (besides referring to the end-of-chapter problems)? If not, why not? If so, what do you hope they will gain by their reading?

Training versus Educating
1. What is the difference between training and educating?
2. Would you describe your primary goal as educating or training midshipmen in core physics? Explain.
3. How do you convey your goal to your students? Do your assessment tools (homework, quizzes, tests, exams, labs, papers, projects...) convey your goal to your students?
Introduction to Case Studies
A case study is a form of project-based learning that is traditionally used in medical, business and law schools. A student working through a case study is in the role of practitioner. Like a practitioner, the student is motivated to learn and sees the relevance of the subject matter. Case studies are educational, not training exercises. When a student works on a case study, we expect the highest levels of thinking, reasoning, problem-solving and communication.

How I Use Case Studies
1. Short case studies are used in lectures to motivate students and flush out preconceptions. (Train collision dialogue)
2. Longer case studies are used to tackle difficult topics on lab days in which no lab is scheduled. (Carol’s broken water heater)
3. Term projects are used to self-motivate students. They find the connection between physics and something they care about, such as sports, movies, books, careers, other classes or extracurricular interests. (Skate boarder accident, building a hover board, rail gun)
   a. Students have fun.
   b. I have found they do much better work on their term projects than they do with traditional assessment tools. They are expected to think much more deeply and with more focus than on a quiz, test, exam or lab, and most rise to the challenge. Many who otherwise have poor performance produce amazing term projects.
   c. It sends the message that physics is relevant. They see that physics offers much more than a collection of facts and equations; it is a way to approach the world’s problems. Physics tells us the universe is knowable and challenges can be met.
   d. There is essentially no way to cheat.
   e. The student and the professor both learn together and an intellectual connection is made, somewhat like that between a research advisor and an apprentice.

Types of Case Studies
1. Historical discovery: Our traditional textbooks and lectures are dogmatic. The assumption is that our students’ heads are empty and we must fill them with the knowledge derived from centuries of experiments, discoveries and derivations with little, if any, attention spent on the scientific process. However, it is that very process that separates our discipline from others and from religion. In a historical case study, students explore the process by which great discoveries are made.
2. Everyday puzzles: Our common experience is full of puzzles that can be solved using physics. (Why does Carol’s hot water heater only produce a little warm water?) A case study may be designed to connect real world puzzles to physics concepts.
3. Other disciplines and interests: Our students have interests and questions that extend well beyond the traditional core physics syllabus. Why is there a lightning rod on the State House? How did ancient Egyptians get obelisks to stand? Why can planes fly upside-down? So another type of case study connects physics with other interesting topics.
4. **Student challenge or laboratory experience:** Of course, physics is a laboratory science that relies on measurements and observations. As in a laboratory experience, students may be presented with data and asked to draw conclusions from that data. We can expect students to use analytical skills, such as plotting data and error analysis. Conclusions may be empirical or theoretical.

**Possible Elements of Case Studies**

1. **Stories:** People are good at remembering and understanding stories. A well-written case study has a single, coherent narrative. The narrative may be very short and simple. There should be no tangents to the main narrative.
2. **Student dialogue:** Fictional student dialogue is a nonconfrontational way to have your students become aware of their own preconceptions.
3. **Data:** Some case studies are based on data collected in a laboratory or observed in nature. Students use data analysis to draw conclusions. [Supermassive black hole]
4. **A goal in the form of a challenge, puzzle or question.**

**How to Get Started (Your Homework)**

1. Find a topic, about the length of a chapter or a few sections, that you expect will be difficult for your students.
2. What makes the topic difficult? Is it abstract? Are there common preconceptions? Does the topic seem irrelevant? Or arcane?
3. Identify one or two concepts that you want your students to understand as result of doing the case study.