

Objectives

To set the tone for interactive learning during the semester in a course that requires quantitative reasoning, and to build student confidence.

Activities

My first day, I present a Fermi Problem* for the students in groups of three to answer. For example:

- What is the number of people per square meter in the 48 states?
- How many piano tuners are there in Chicago?
- How long would it take to walk from the classroom to a different city?

They think that they need to go elsewhere to get information in order to answer the question. They don't. Members of the group have pieces of information that will help and at first they do not realize it. In the example above (the number of people per square meter) you see that there has to be a conversion of units. Someone will know how or someone can guess. As to the dimensions of the U.S. someone will have a rough guess usually in miles and when they get the required number, they are surprised that so many groups came up with roughly the same answer even though the guesses that they made were slightly different.

Jon Gaffney (The Physics Teacher, Vol. 53, March 2015) notes that in the third question (the time it would take to walk to a different city), students naturally begin by estimating distance and then proceed with a calculation for average velocity. Assumptions made by students leave much room for discussion.

Effectiveness

I started this in college courses in 1995 and never had any reason to change. I have presented these techniques at various conferences, and teachers are always surprised at how well it works. Admittedly, one has to be a bit of a ham, but it is easy to become one as you build up a repertoire of answers and a few jokes.

Jon Gaffney (The Physics Teacher, Vol. 53, March 2015) notes that students are able to get much better results working together with others than they do alone, and also realize that there is not one right answer to some questions. They also gain confidence in their ability to figure these things out – especially if the instructor is attentive to the possibly threatening nature of the activity, keeping students from feeling incompetent or isolated.

** A Fermi problem or Fermi question is an estimation problem aimed to teach skills in approximation, dimensional analysis, and the importance of identifying assumptions that go into an approximation. Named after physicist Enrico Fermi, known for his ability to perform such approximations to high accuracy.*

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Materials & Resources

Find other Fermi Questions here:

U. Maryland: <http://bit.ly/3E5890>

The Physics Teacher:
<http://bit.ly/13QFqnu>

Math Forum: <http://bit.ly/5A3ktw>

Prof. Meade Brooks (with annotated
solns) <http://bit.ly/W0TxFT>

Classroom Context

Various

Time Requirement

Varies

About this Project

This is one of a set of materials compiled for instructors to draw upon in order to frame non-traditional modes of classroom teaching for their students. Our hope is that these materials can help reduce any student resistance to such techniques.

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Other materials available online at
www.colorado.edu/sei/fac-resources