Order of Magnitude (OoM) Estimation Workshop

Dartmouth College — November 12, 2015

Purpose

Learning science is not about memorizing facts, equations, and numbers, but developing conceptual understanding and problem solving intuition. These are the most translatable skills we can help our students develop, and they are useful in a wide array of fields, not just the sciences. A well-known tool for honing these abilities is *order-of-magnitude estimation* (OoM, also known as "Fermi problems"). When solving OoM problems, students use existing knowledge to make educated guesses about the approximate values of parameters and simple arithmetic to estimate a quantity. The "right answer" is just within a factor of ten (or so) — we aren't concerned with exact calculations, but gaining some general insight into the question at hand.

These techniques are commonly taught to and used by advanced students in the sciences, but younger students would benefit from practicing them early in their education. Astronomy is particularly well suited to OoM estimation, as the numbers (and their associated uncertainties) are often quite large. However, estimating astronomical values can be a daunting task, until you realize that the same techniques you can use in every day life apply universally!

Our goal is to introduce you to OoM techniques with examples from here on Earth, guide you through extending these approaches to astronomy, and finally to help you develop your own OoM problems suited to your subject area and students' needs. You can then implement these in your classroom, using us and your colleagues as a resource to help you along.

Schedule

Here is a rough outline of today's workshop:

9:00 - 9:30	Welcome, logistics
9:30 - 10:00	The classic problem: how many candies in the jar?
10:00 - 11:30	Group work on "two-step" OoM problems
11:30 - 12:00	Expert example
12:00 - 1:15	Lunch
1:15 - 2:00	Incorporating OoM into your lessons, Next Gen. Science Standards
2:00 - 3:00	Build your own "two-step" OoM problems
3:00 - 3:15	Coffee break
3:15 - 4:15	Continue developing problems/lessons
4:15 - 5:00	Review & wrap-up

Looking Ahead

After leaving here today, you should be ready to incorporate OoM estimation into your lesson plans. We would like you to keep in touch with us and your peers as this process evolves. Please don't hesitate to contact us for advice on using these techniques successfully. Over the course of the next several months, you will also be hearing from us as we check in to see how things are going. You may be asked to complete some surveys online, and to share your lesson plans.

Near the end of the school year, we will reconvene (either in person or via conference call) to discuss our successes and failures using OoM estimation in our classrooms. This will also serve as an opportunity to share your lessons with other teachers in order to grow your bank of problems. We will also gather your lessons, along with our own, for the website and distribution to the wider community.

Resources

You can find Dartmouth's OoM estimation website, including all of the papers you received today, as well as additional resources, here:

http://sites.dartmouth.edu/estimation