SLAM: Science Leadership and Management
UC Berkeley

Teaching & Mentoring
Undergraduate Students

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1 student doing science

doing science

scientist
Faculty mentorship of undergraduates

Where?
• All colleges and universities
• Perhaps most closely at PUIs (primarily undergraduate institutions)

In what contexts?
• Classroom
• Lab courses
• Research
• As faculty mentor to clubs, student organizations

Carefully designed in advance

Why?
• Many reasons
• Mine: foster young “scientists in training”
A quick story: Teaching organic chemistry lab

My goal: To train undergraduates how to think, perform, and behave more like professional scientists.

Why?
- I see a connection between
  - What chemists do
  - How chemists think
  - What chemists write (say)

This connection was missing in my students, in part, because they were doing boring literature procedures, and they knew it. This prevented many students from joining the academic discourse of chemists (thinking authentically as chemists).
The fun of discovery vs. the drudgery of repetition

"You are completely free to carry out whatever research you want, so long as you come to these conclusions."
Engendering authenticity in our teaching labs

Designing ways for students to think authentically like scientists

- *doing science* in lab
- rather than confirming known results
Our realizations:
For students to think authentically as scientists it requires
• a genuine scientific question, AND
• reliable and meaningful data

Unfortunately, most of our old experiments
• lacked an authentic scientific context,
• generated a single datum (rather than a data set),
• generated unreliable data.

Thus, we re-designed our experiments aiming to involve:
1. Collaborative generation of reliable & meaningful data,
2. authentic data analysis,
3. progressive training in data interpretation, and
4. data-driven decision-making.
Advantages of this lab teaching approach

1. **Collaboration** enables a meaningful, class-wide investigation of an authentic scientific question.
2. **Projecting and discussing data during lab**, allows adjustments to be made during lab.
3. **Replication** resolves most reliability problems.
4. **Scatter** focuses students on their technique, rather than reflexive reliance on “experimental error”.
5. Having two teams per condition and comparing results leads to inter-student conversations aimed at improving technique.
6. Data that **oppose** expectations cannot be dismissed. Instead, students must generate a cogent explanation for unexpected results.
7. **Lab culture** changes. More students . . .
   - Feel more **responsible**
   - Take **pride** in their lab-work
8. **Simplifies grading** because all students have the same data.
Mentoring undergraduates in research

My goal is the same as in my teaching:

To train undergraduates how to think, perform, and behave more like professional scientists.

Challenges we might discuss

- Students typically have little/no prior experience
- Accuracy and precision of data
- Documentation, data storage, notebooks
- Research ideas and constraints
- Physical resources & equipment
- Intellectual resources & library
- Funding & grant proposals
- Writing manuscripts