Translating Teaching Pedagogy to Mentoring

Caltech Conference on Mentoring Undergraduate Researchers
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Before we start...

Think about the mentors you have had—the good... and the not-so-good

- What were the strengths of your mentors?
- What did they do that helped you learn something difficult or achieve success?

- What were challenges you faced with mentors?
- What did they do that didn’t work for you?
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What is our role as mentors?

Mentors teach mentees techniques and guide students as they learn essential and invaluable research skills.
Translating Teaching Pedagogy to Mentoring

- Getting to Know your Mentee (and what they know)
- Backwards Designing your Summer
- Building and Assessing Skills
- Mentoring *your* Mentee… and Letting your Mentee Mentor You
Getting to Know Your Mentee (and what they know)

- A freshman who has never worked in a lab before and a senior who has already completed 3 SURFs in your field are very different students!

Pedagogy Involved:
- Student Prior Knowledge
- Knowledge Organization
Student Prior Knowledge

- Students have ideas and backgrounds that shape the way they learn new materials.

- **Effective** teaching and mentoring helps students builds off of a sturdy prior knowledge base

- **Ineffective** teaching and mentoring ignores prior knowledge and can builds off an unstable knowledge base
Think about your mentee...

- What is your mentee’s background?
  - What relevant coursework have they taken?
  - Have they done research before?
  - How many times?
  - In a related field?
  - What did they do?

- If you don’t know… Ask your mentee!
Knowledge Organization

The way your mentee organizes her knowledge might be different than how you do.

- Your Research
- Their Prior Research
- Their Prior Classes
Knowledge Organization

- The way your mentee organizes her knowledge might be different than how you do.

**Example:** Running an experiment

- If mentees do not understand what they are doing, they will be less efficient and less able to adapt to changes.
Mentee Motivation

- When students value the work they are doing, they are more motivated and perform better.

- **Consider**: What motivates your student? Why did they ask to do research in your lab this summer?
Setting goals for the summer

- What are your goals for your mentee?

- What do you want your mentee to have completed at the end of the summer?

- What skills do you want your mentee to have developed by the end of the summer?
Backwards Designing your Summer

- You’ve identified goals for your students, now how are you going to help them meet those goals?

- Pedagogy Involved:
  - Learning Outcomes (Goals)
  - Learning Opportunities (Skill Building Activities)
  - Assess Learning (Measuring Mastery)
Learning goals determine content, activities, and assessments!
Establishing Learning Goals

- Learning goals articulate the knowledge and skills you want students to acquire or the outcomes you want students to achieve by the end of their experience.

- Learning Goals should...
  - Be student-centered
  - Break down task and focus on specific processes
  - Be measurable
Breaking Down Our Goals

Goal: I want my mentee to finish their project by the end of the summer
Breaking Down Our Goals

Kelsey’s Goal Last Summer:
My mentee will test the cytotoxicity of a drug in 16 new cell lines and determine how the cells die.

- Part 1: Make the drug (follows the literature)
- Part 2: Test the drug in each cell line (protocol from kit)
- Part 3: Determine cytotoxicity (analyze Part 2 data)
- Part 4: Test conditions for cell death determination (new)
- Part 5: Determine cell death (follows the literature)
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- **Part 1:** Make the drug (follows the literature)
- **Part 2:** Test the drug in each cell line (protocol from kit)
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- **Part 4:** Test conditions for cell death determination (new)
- **Part 5:** Determine cell death (follows the literature)

* Student-centered
* Break down task and focus on specific processes
* Be measureable
Breaking Down Our Goals

Kelsey’s Goal Last Summer:
My mentee will test the cytotoxicity of a drug in 16 new cell lines and determine how the cells die.

- Synthesize the drug
- Confirm synthesis of drug
- Purify the drug
- Confirm purity of drug
- Learn how to do cell culture
- Learn how to thaw cells
- Learn how to do an MTT assay
- Practice the MTT assay
- Order and receive 16 cell lines

- Research 16 cell lines to determine appropriate growth conditions
- Order and receive appropriate media
- Make stocks of each cell line
- Thaw fresh cells every 3 weeks
- Test each cell line over a wide concentration range
- Narrow the concentration range
- Do each experiment in triplicate
- Troubleshoot as needed.

* Student-centered
* Break down task and focus on specific processes
* Be measurable
Breaking Down Our Goals

Better Goals for Last Summer:

- My student will be able to synthesize and purify the drug
- My student will be able to structurally characterize the drug
- My student will perform a successful cytotoxicity assay on a test compound
- My student will research the cell lines she uses and practice growing them
- My student will test the drug she made in 16 different cell lines to determine cytotoxicity
- And so on....

* Student-centered
* Break down task and focus on specific processes
* Be measureable
Choose one of your goals you wrote for your mentee from the previous activity.

Break down your goal into the concepts, skills, and tasks that go into successfully completing it.

Is your goal student-centered and measurable?
Examples of Goals For Different Students

What do you want your mentee to get out of the summer?

- **Experimental Skills**
  - Learn new techniques
  - Work safely
  - Keep a (good) lab notebook
  - Deal with failure
  - Work on expensive equipment
  - Troubleshoot experiments

- **Communication Skills**
  - Present and communicate data
  - Write research summaries and reports
  - Describe complications

- **People Skills**
  - Collaborate with others
  - Work around schedules
  - Dependability
  - Cleanliness and upkeep of communal areas
  - Ask for help

- **General Skills**
  - Work efficiently
  - Work consistently
  - Manage work-life balance
  - Read primary literature
Examples of Goals For Different Students

What do you want your high school mentee to get out of the summer?

- Become acquainted with research and excited about science
- Become familiar with experimental techniques
- Become familiar with data analysis
- Understand and practice good lab safety
Examples of Goals For Different Students

- What do you want your freshman mentee to get out of the summer?
  - Complete a specific aspect of a larger project OR Make significant progress on a new project
  - Learn about failure and practice troubleshooting
  - Develop good work habits (work hours, communal spaces)
  - Read and understanding primary literature
  - Ask for help with troubleshooting when they encounter a problem
Examples of Goals For Different Students

- What do you want your experienced mentee to get out of the summer?

  - Complete several parts of a project
  - Design their own experiments by looking at the literature
  - Troubleshoot their own problems
  - Produce publication-quality work that will go into a paper
Building and Assessing Skills

1. Establish Learning Goals
2. Provide Learning Opportunities
3. Assess Learning
4. Use Results to Revise
0. Identify your Audience!
2.5 Give Feedback to Students

Learning goals determine content, activities, and assessments!
Building and Assessing Skills

- Learning goals inform how you design tasks and activities that will be used to determine if your mentee has achieved those learning goals.

- Pedagogy Involved:
  - Formative Assessment (Skill Building Activities)
  - Summative Assessment (Measuring Mastery)
  - Feedback
Learning goals determine content, activities, and assessments!
Learning Goal
My mentee will develop good work habits that are important for scientists.

Learning goals determine content, activities, and assessments!
What skill building activity would you use?

- Completing experiments
  Learning Goal: My mentee will complete the purification of 4 mutant proteins by the end of the summer.

- Reading the literature
  Learning Goal: My mentee will be able to explain relevant literature and identify how the current research project fits into the larger scientific context.

- Working efficiently and consistently
  Learning Goal: My mentee will develop good work habits that are important for scientists.

- Writing research summaries and reports
  Learning Goal: My mentee will describe, discuss, and report data using the conventions of American Chemical Society.

- Presenting and communicating data
  Learning Goal: My mentee will present clear research findings at SURF Seminar Day.
How can help *your* mentee build skills?

- Choose one of the learning goals you have written for your mentee.
- Write an activity that will help your mentee build skills related to your learning goal.
Learning goals determine content, activities, and assessments!
Assessing Mentee Learning

- How will you know if your mentee “got it”?
- What counts as acceptable evidence of understanding in your lab? In your discipline?
- What assessment tasks will support students in developing understanding?
- How will the tasks identify and differentiate levels or degrees of understanding throughout the learning process, not just at the end?
Checking for Learning

The Power of Discussion

The act of explaining one's understanding to others or themselves shows the greatest learning gains and long-term retention of information.

Yes/No: Do you understand what we did today? OR Does that make sense?

Discussion: Please explain what you did today and why you did it.
Checking for Learning

Checking for Confidence and Background

- Are you comfortable working alone?
- Do you want me around for part of the experiment?
- Would you like to text me if you have a question?
- How comfortable do you feel with this technique?
- Have you learned this technique before?
- Where did you learn this technique?
- How have you applied this technique?
Checking for Learning

- Check for Conceptual Understanding and Misconceptions
  Asking students to make predictions can make prior knowledge and misconceptions explicit & visible, rather than implicit & invisible.

- What results to you expect and why?
- What would it mean if X, Y, or Z happens?
Measuring Mastery (Summative)

▶ Writing research summaries and reports

**Learning Goal:** My mentee will practice describing, discussing, and reporting data using the conventions of American Chemical Society journals.

**Assessment:** Complete periodic SURF Progress Reports and the Final SURF Report.

▶ Presenting and communicating data

**Learning Goal:** My mentee will practice discussing and presenting research findings periodically throughout the summer and at SURF Seminar Day.

**Assessment:** Present a poster or a PowerPoint presentation at SURF Seminar Day.
Learning Goal

My mentee will develop good work habits that are important for scientists.

Learning goals determine content, activities, and assessments!
How can you assess your mentee’s learning?

- Consider the same learning goal from the previous activity.
- Think of how you will measure if your mentee has mastered your learning goal.
- Does your skill building activity from Activity #4 directly help prepare your mentee for how you will measure skill mastery?
Think-Pair-Share

- Turn to a neighbor and discuss your chosen learning goal, your skill building activity, and your assessment for your mentee!
  - Describe your learning goal.
  - Describe your skill building activity.
  - Discuss how your activity aligns with your learning goal.
  - Describe your assessment idea and how you will help your mentee prepare for the assessment.
Mentoring your Mentee...and Letting your Mentee Mentor You
Asking Your Mentee for Feedback

- **Experimental Skills**
  - Learn new techniques
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Asking Your Mentee for Feedback

Create open communication between yourself and your mentee about:

- Goals for the summer
- Time management
- Communication
- Management style
- Work environment
Backwards Design

0. Identify your Audience!

1. Establish Learning Goals

2. Provide Learning Opportunities

3. Assess Learning

4. Use Results to Revise

2.5 Give Feedback to Students

Learning goals determine content, activities, and assessments!
Backwards Design

Goal For Mentees

- Writing a quality research report at the end of the summer
- Giving the best presentation on SURF seminar day
- Completing all aspects of the project
- Completing an additional side project
- Develop good work habits
- Read and understand the literature
- And so on… and so on….

1. Establish Learning Goals
2. Provide Learning Opportunities
3. Assess Learning
4. Use Results to Revise
As you leave, think about…

What are your goals for yourself?

What is a mentoring goal that you want to have practiced by the end of the summer?

How will you help yourself achieve that mentoring goal?

L. Suskie, 2009, *Assessing Student Learning*

Wiggins, Grant and Jay McTighe, 2001, *What is Backward Design?*