Translating Teaching Pedagogy to Mentoring

Caltech Conference on Mentoring Undergraduate Researchers
Thursday, May 11, 2017
Presenters: Kelsey Boyle and Rebekah Silva
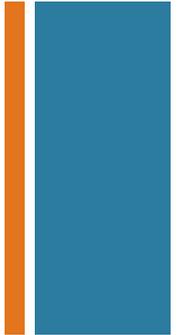
+ Before we start…

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?

What do undergrads learn to do when they work in a research lab?

- **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
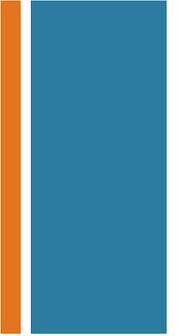   - Describe complications

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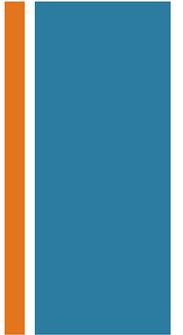   - Ask for help

- **General Skills**
    - Work efficiently
    - Work consistently
    - Manage work-life balance
    - Read primary literature

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

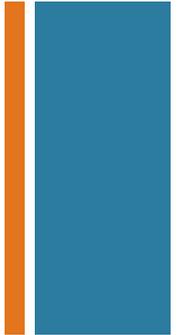- Mentoring *your* Mentee… and Letting your Mentee Mentor You

Getting to Know Your Mentee (and what they know)
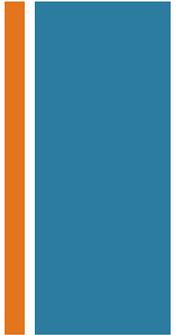
- A freshman who has never worked in a lab before and a senior who has already completed 3 SURFs in your field are very different students!

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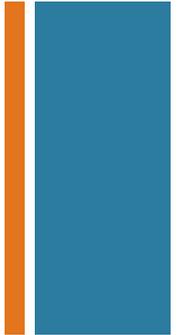
Student Prior Knowledge

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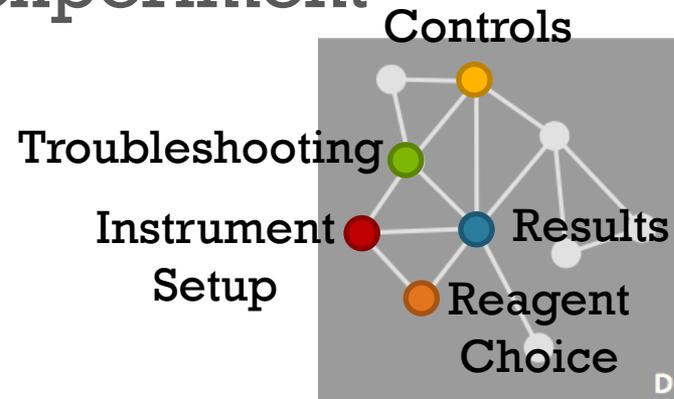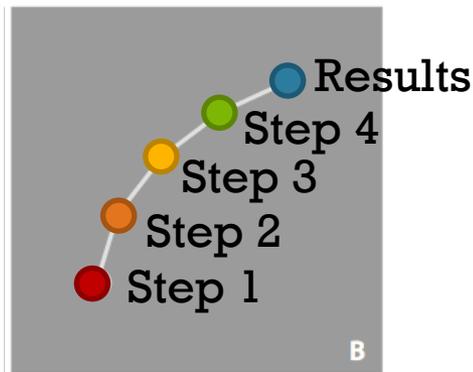
■ The way your mentee organizes her knowledge might be different than how you do.

● Your Research

● Their Prior Research

● Their Prior Classes

Novice

Novice
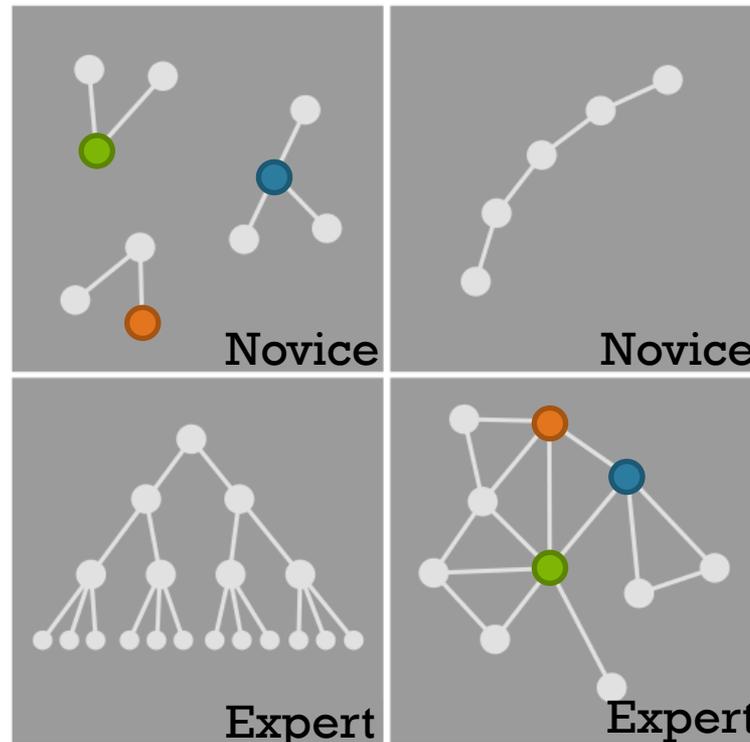
Expert

Expert

Knowledge Organization

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

■ **Example**: Running an experiment

Results
Step 4
Step 3
Step 2
Step 1

Controls
Troubleshooting
Instrument Setup
Results
Reagent Choice

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

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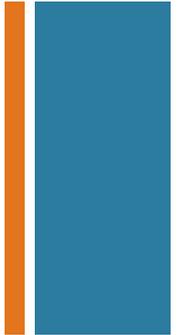
- When students value the work they are doing, they are more motivated and perform better.

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

Expectancy

Value

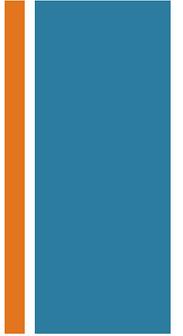Motivation LEADS TO Goal-directed behavior SUPPORTS Learning and Performance
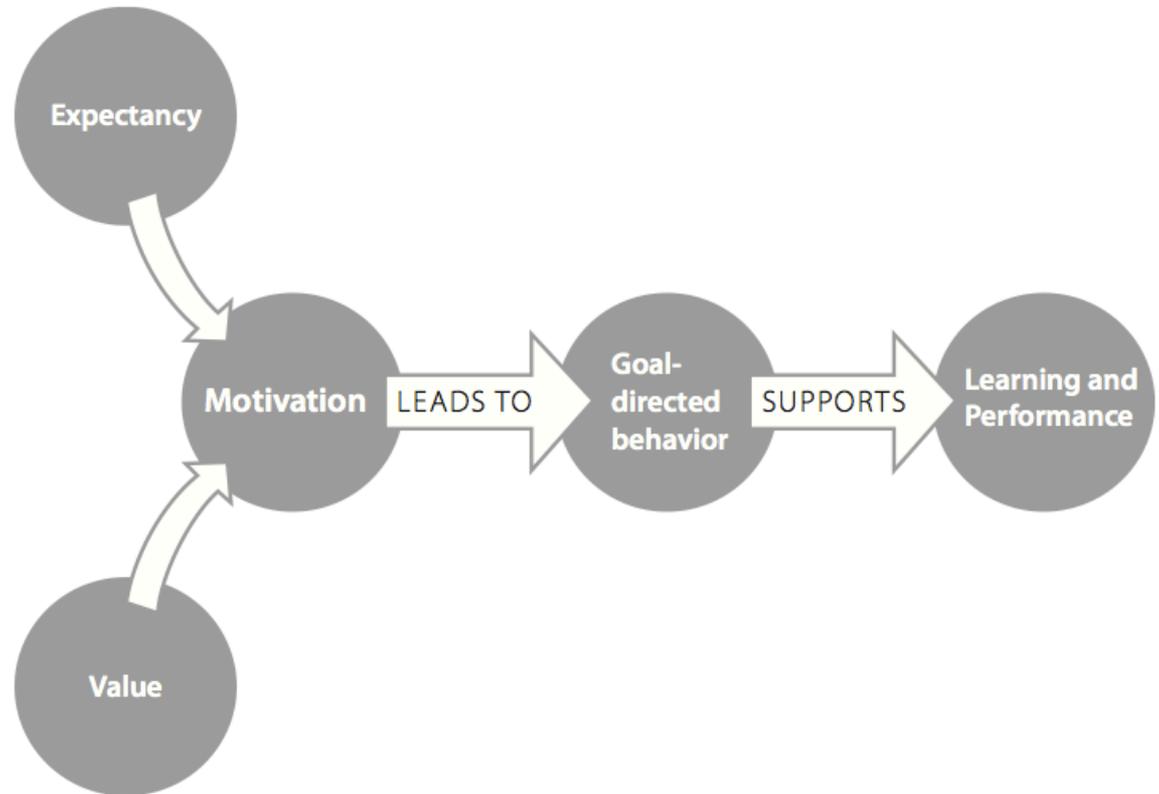
+ Setting goals for the summer

- 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?
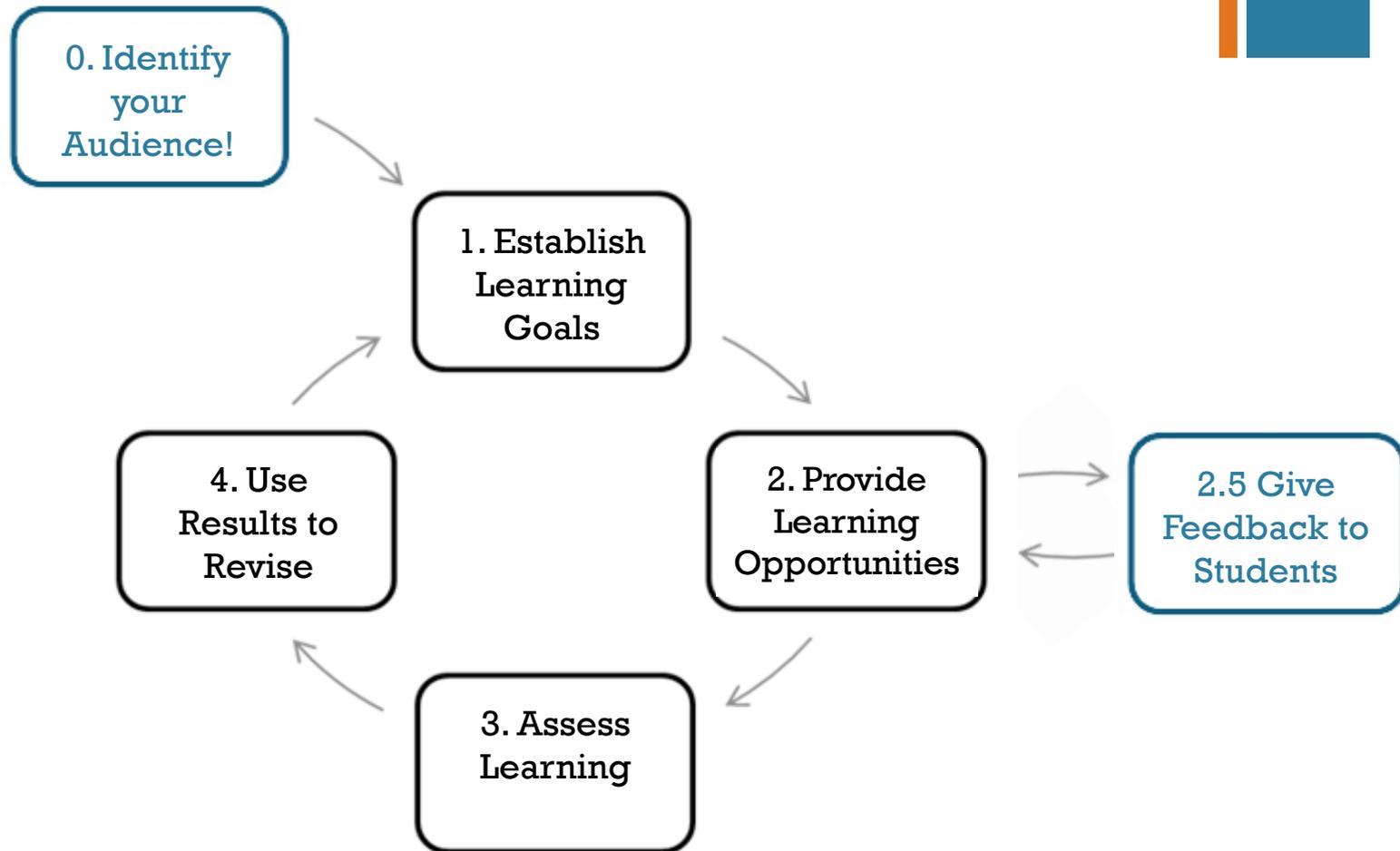
# Backwards Designing your Summer

- 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)

Backwards Design


```
        ┌──────────────┐
        │ 0. Identify  │
        │    your      │
        │  Audience!   │
        └──────────────┘
                ↓
        ┌──────────────┐
        │ 1. Establish │
        │   Learning   │
        │    Goals     │
        └──────────────┘
       ↗                ↘
┌──────────────┐    ┌──────────────┐  →  ┌──────────────┐
│ 4. Use       │    │ 2. Provide   │     │ 2.5 Give     │
│ Results to   │    │ Learning     │  ←  │ Feedback to  │
│ Revise       │    │ Opportunities│     │ Students     │
└──────────────┘    └──────────────┘     └──────────────┘
       ↖                ↙
        ┌──────────────┐
        │ 3. Assess    │
        │   Learning   │
        └──────────────┘
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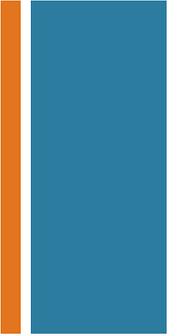**Learning goals determine content, activities, and assessments!**

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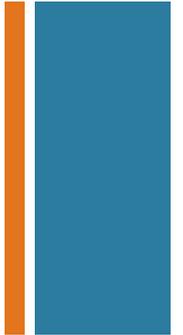
- Learning goals articulate the knowledge and skills you want students to acquire or the outcomes you want students to achieve by the end of their experience

- 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)

+ Breaking Down Our Goals

Kelsey's Goal Last Summer:
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- 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)~~

Breaking Down Our Goals

* Student-centered
* Break down task and focus on specific processes
* Be measureable

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
- Troubleshot as needed.

Breaking Down Our Goals

* Student-centered
* Break down task and focus on specific processes
* Be measureable

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….

+ Refining your goals

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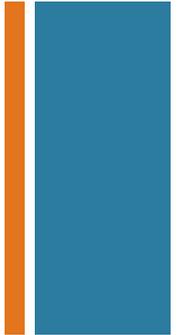
What do you want your mentee to get out of the summer?

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

- Communication Skills
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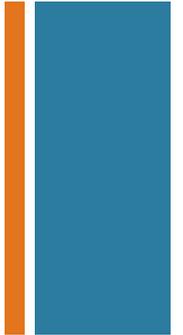 - Describe complications

- People Skills
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  - Cleanliness and upkeep of communal areas
  - Ask for help

- General Skills
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  - Work consistently
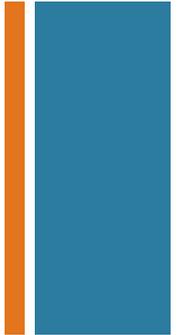 - Manage work-life balance
  - Read primary literature

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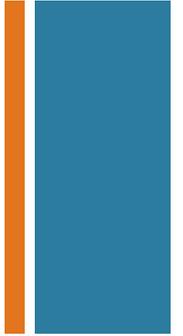
- What do you want your experienced mentee to get out of the summer?

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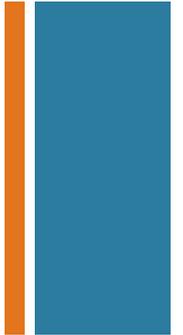 - **Produce** publication-quality work that will go into a paper

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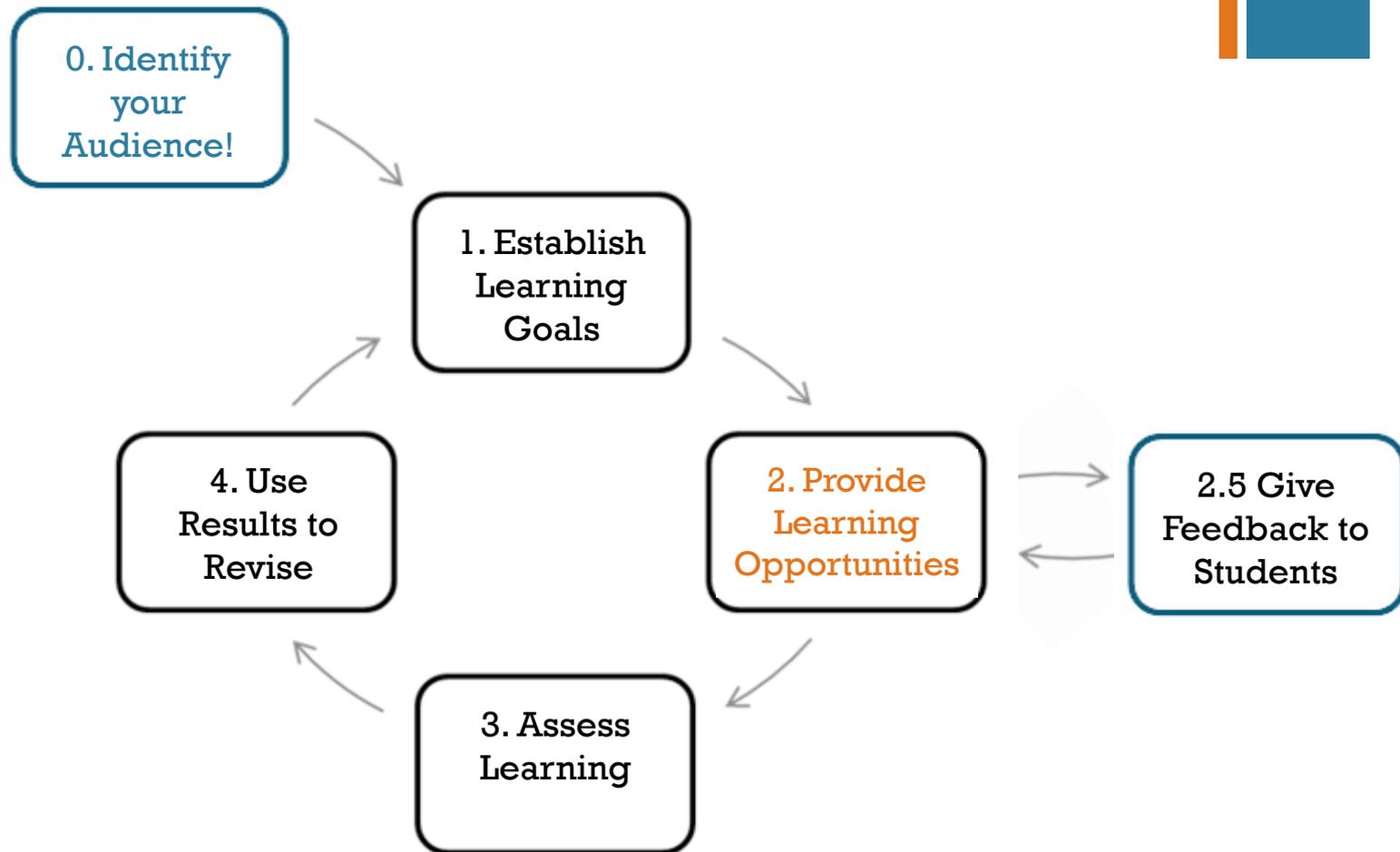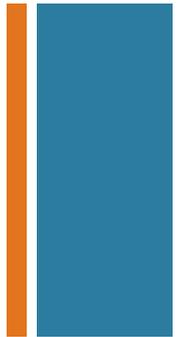
Learning goals determine content, activities, and assessments!
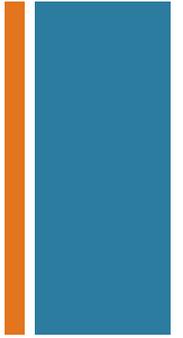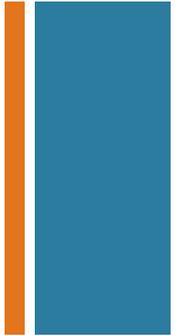
Building and Assessing Skills

- 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)
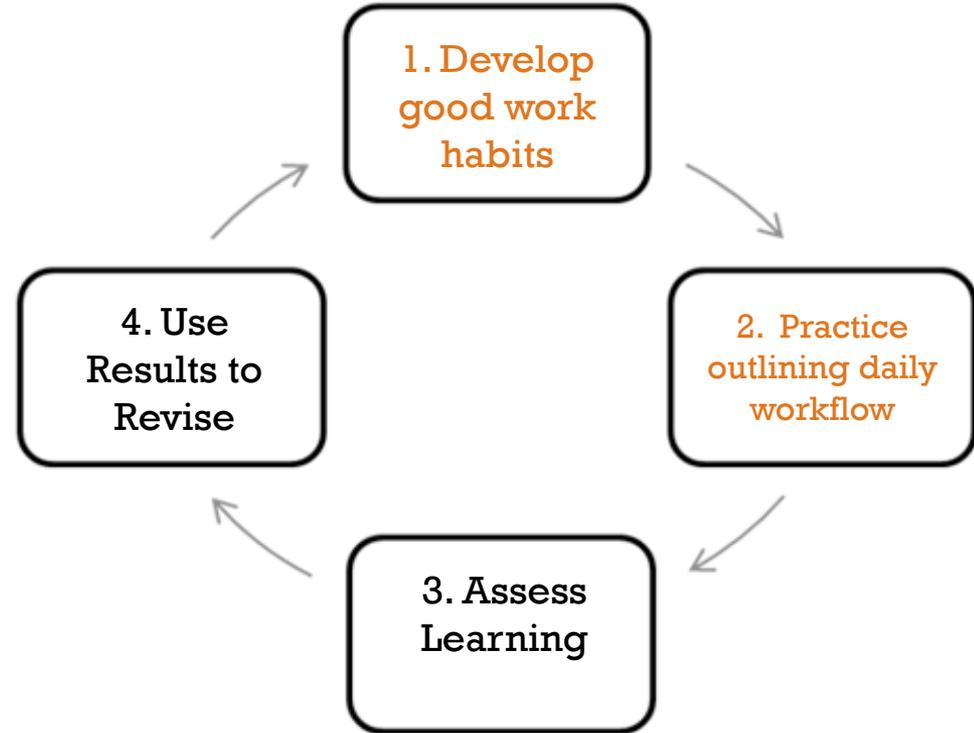 - Summative Assessment (Measuring Mastery)
  - Feedback

Learning Goals

Learning goals determine content, activities, and assessments!

Backwards Design Example

Learning Goal

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

1. Develop good work habits
2. Practice outlining daily workflow
3. Assess Learning
4. Use Results to Revise

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.*

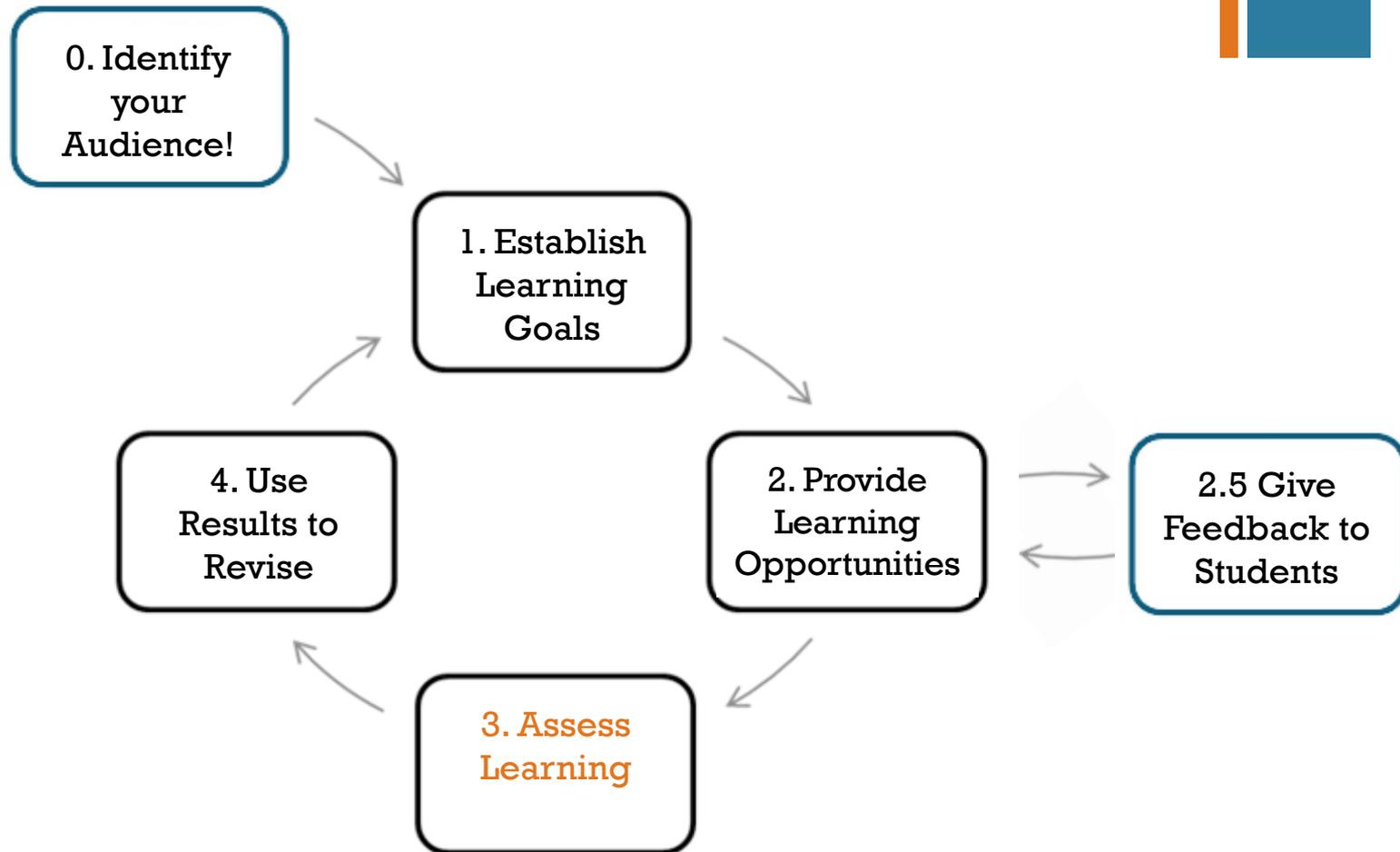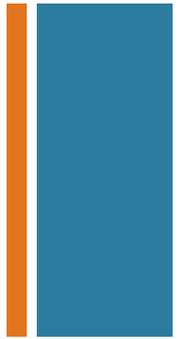▶ **Presenting and communicating data**
Learning Goal: *My mentee will present clear research findings at SURF Seminar Day.*

+ 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.
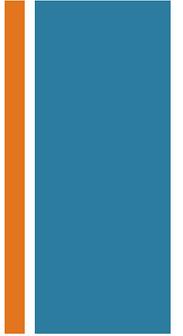
Building and Assessing Skills

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
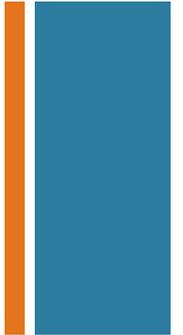
- **The Power of Discussion**

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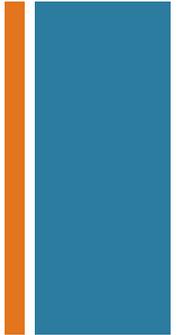
- Check for Conceptual Understanding and Misconceptions
Asking students to make predictions can make prior knowledge and misconceptions explicit & visible, rather than implicit & invisible.

- 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.
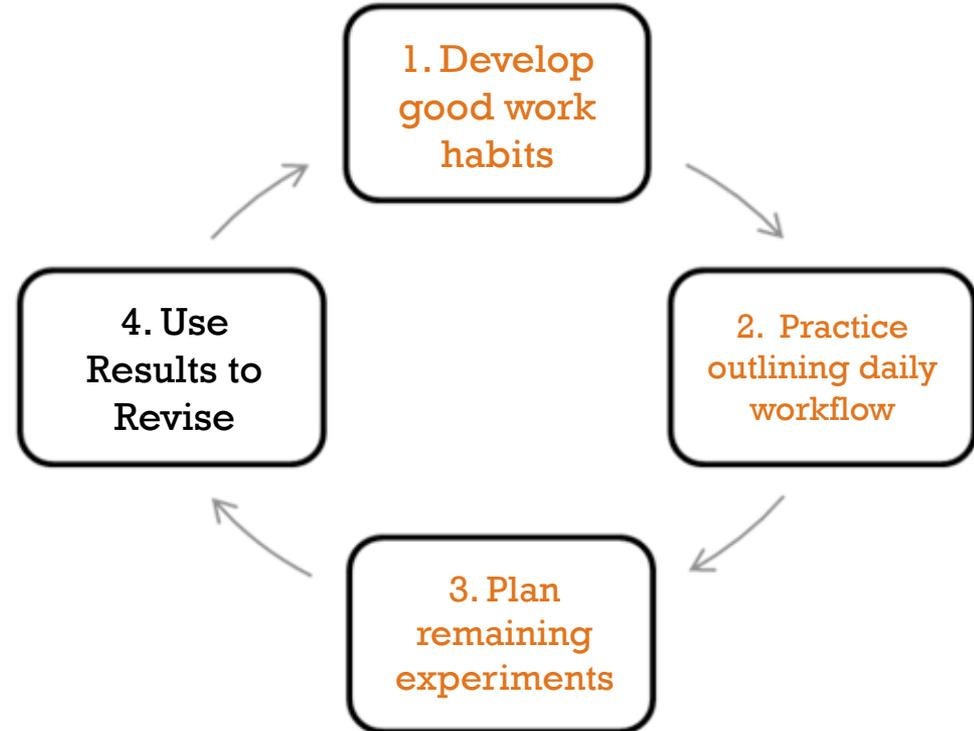
Assessment: Present a poster or a PowerPoint presentation at SURF Seminar Day.

Backwards Design Example
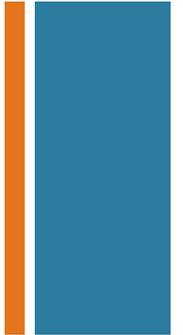
Learning Goal

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

1. Develop good work habits

2. Practice outlining daily workflow

3. Plan remaining experiments

4. Use Results to Revise

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
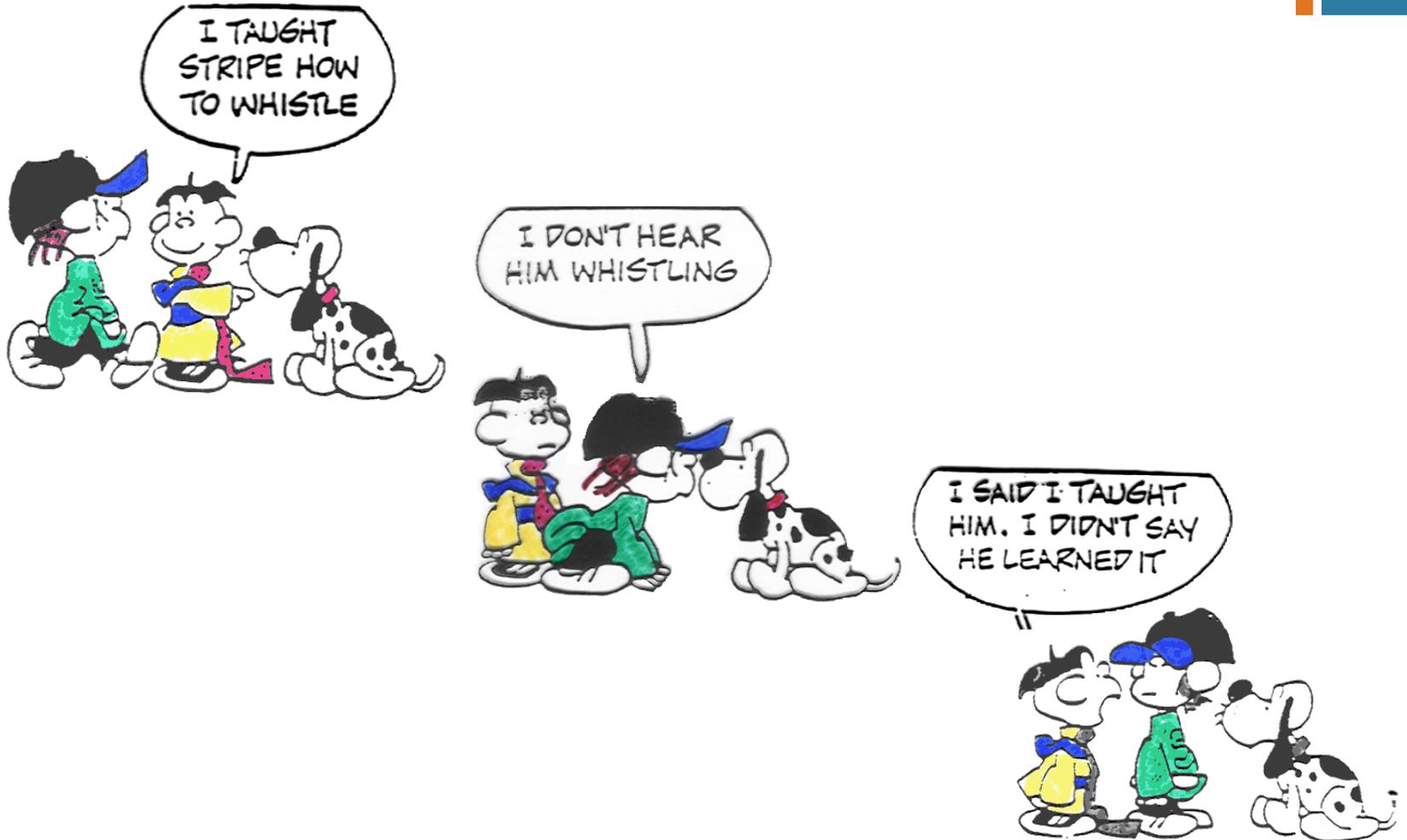
Asking Your Mentee for Feedback
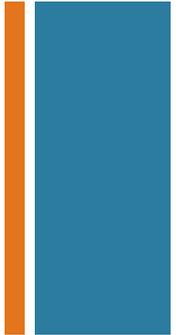
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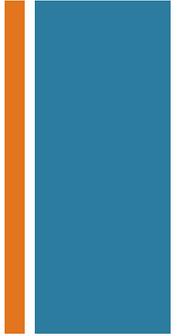 - Describe complications

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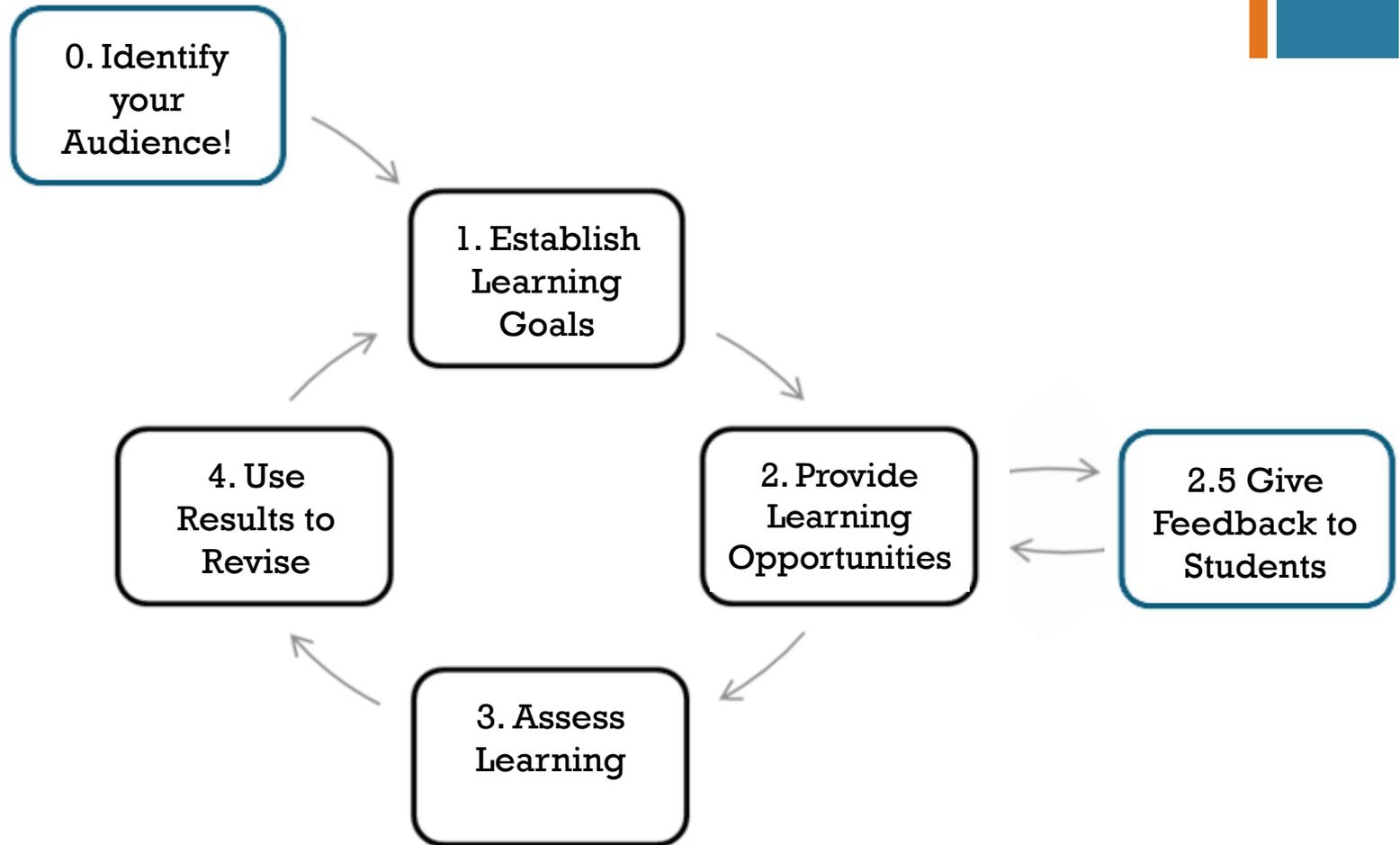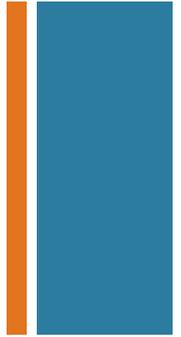 - Manage work-life balance
  - Read primary literature

Asking Your Mentee for Feedback

- Create open communication between yourself and your mentee about:
  - Goals for the summer
  - Time management
  - Communication
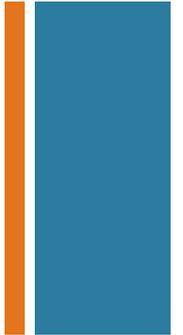 - Management style
  - Work environment

Backwards Design

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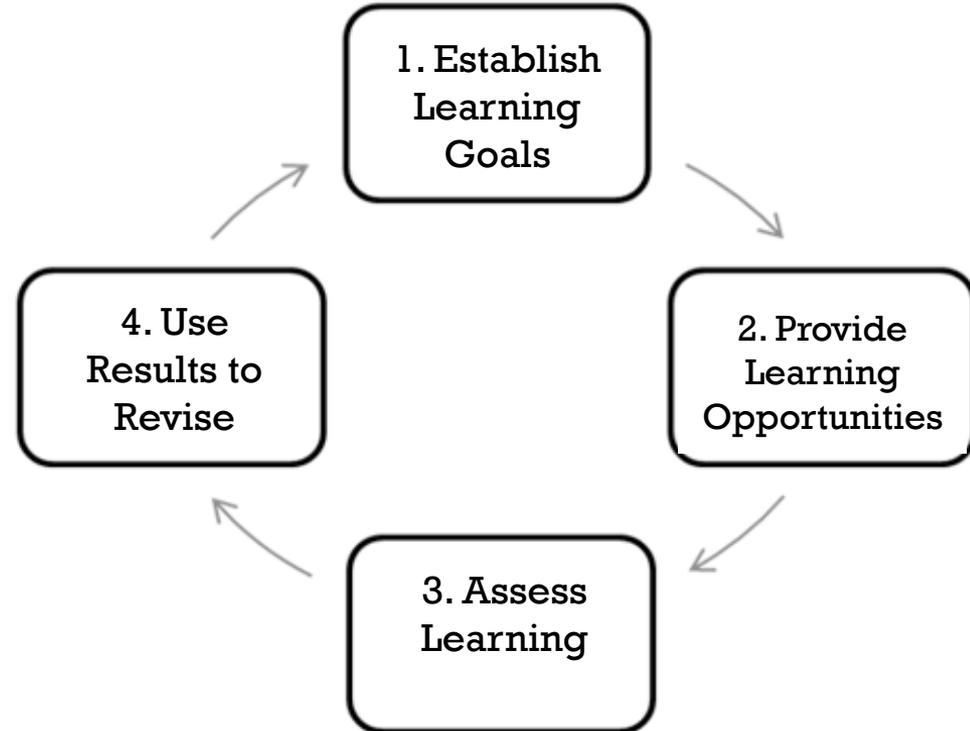- 4. Use Results to Revise

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 <u>all aspects</u> 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?

References and Resources

- Ambrose, Susan A., et al. 2010, *How learning works*.

- L. Suskie, 2009, *Assessing Student Learning*

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