**Backward Design Guidelines for Building your course**

Adapted from [Cooper et al. (2017)](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5440170/)

### Defining your goals and how to achieve them

In a well-designed CURE, the learning goals align with the research goals and the assessments align with learning goals. In other words, the research, class activities, and assignments help students to develop the skills and knowledge that you want them to take away from the course, and the assessments determine whether this has been achieved.

First, define the research project your students will undertake in the course:

1. **Identify desired results: RESEARCH**

What is the overarching research question, hypothesis, or concept you want students to explore?

1. **Determine acceptable evidence**:

How do you test/explore your research question? What comparison will you make or what data will you collect?

1. **Plan the learning experience and instruction:**

Lay out the protocols and steps that students will work through to as part of addressing the research goal.

Now, consider the learning goals in the context of your research goals:

1. **Identify desired results: LEARNING**

What are the most important skills and knowledge you want students to take away from the of the course? You should be able to accomplish these learning goals within the bounds of the research project you choose.

1. **Determine acceptable evidence**:

How will you assess whether students have achieved the desired learning outcomes (knowledge and skills)?

1. **Plan the learning experience and instruction:**In the context of your learning goals and desired output, consider:
   1. What enabling knowledge (facts, concepts, principles) and skills (processes, procedures, strategies) will students need in order to perform effectively and achieve the desired results?
   2. What activities will equip students with the needed knowledge and skills?
   3. What will need to be taught and coached, and how should it best be taught, in light of performance goals?
   4. What materials and resources are best suited to accomplish these goals?

Check to see how your research goals and learning goals align by filling this table with your answers to the previous questions:

|  |  |  |
| --- | --- | --- |
| Backwards Design Step | Research Goals | Learning Goals |
| 1) Identify desired results |  |  |
| 2) Determine acceptable evidence |  |  |
| 3) Plan learning experience and instruction |  |  |
| 4) Revise and iterate | Troubleshoot experiments to see if experiment leads to reliable results | Adapt assessments to see whether learning activities lead to learning goals |

Continue revising your research and learning goals until they feel that they are in agreement. Also, please take into consideration whether your goals can be accomplished within the timeframe of your CURE course or module and whether they are appropriate to the level and number of students who will enroll in your course.

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### Scaffolding: Planning the activities to support your goals

Now that you have identified the the goal of your course, the next set of questions take into consideration the final outcomes of your course and the steps you will take to get there.

1. What are the main goals of the final capstone assignment?
2. What are the skills and knowledge necessary to complete this assignment?
3. What smaller assignments will help students to acquire background knowledge and build these skills, as well as receive feedback to let them know whether they are on track?
4. Do you have rubrics to assess these types of assignment? If so, please bring them with you to the institute.

|  |  |  |
| --- | --- | --- |
| Phase  (Edit phases as needed) | Skills/Background knowledge | Assignment  (Fill in your own) |
| Phase 1: Current state of the Field |  | *Ex. Literature Review or Introduction section of a paper* |
| Phase 2: Learn research techniques and develop research question |  | *Ex. Write a proposal, or methods section of paper* |
| Phase 3: Collect Data and Analyze |  | *Ex. Data visualization and analysis assignment* |
| Phase 4: Communicate Findings |  | *Capstone Project* |

**Possible assignment types to consider:**

* Participation
  + Consider using the [Teamwork VALUE rubric](https://www.aacu.org/value/rubrics/teamwork) for self-reflection as well as your assessment
* Lab Notebook Checks - Students should maintain a lab notebook containing protocols, observations, and data. This can be done electronically in Google Drive or in [Lab Archives](https://library.brown.edu/info/labarchives).
* Capstone Project: poster, presentation, or paper to synthesize the work done in the course and make suggestions for future research project. Smaller assignments should precede this assignment and scaffold its components
* Reflections
* Quizzes
* Possible assignments to build skills for the capstone project
  + Literature Review - early in the semester students should begin to synthesize relevant literature in the field to motivate their hypothesis. This should be supported by smaller assignments such as
    - In class discussions of papers - to help students become more comfortable with reading scientific papers
    - Online discussions of papers
    - Crowd-sourcing of annotated bibliography
  + Research Proposal - before embarking on their experiment, students must clearly define their hypothesis, outline their experiment, and interpret possible experimental outcomes
  + Research Reports (partial or full) - As students collect and analyze data, small assignments allow them to practice data visualization and interpretation of results.
    - Partial results and discussion sections - Plot data from one protocol or activity and write results text, figure caption, and discussion/interpretation of the data.
  + Peer Editing - peer feedback can be a useful exercise for learning scientific communication skills. Provide clear guidelines and the rubric for how to evaluate their peers’ work.
  + Annotated bibliography

Cooper, K. M., et al. (2017). "Define Your Goals Before You Design a CURE: A Call to Use Backward Design in Planning Course-Based Undergraduate Research Experiences." Journal of Microbiology & Biology Education 18(2): 18.12.30.