“How do you know your students are learning?”

As you enter, list on the board:
• the forms of student assessment you currently use.

Optional
• your goals for this session …
How do you know your students are learning?
Why does student engagement matter?

Adriana Signorini
Center for Research on Teaching Excellence
Students Assessing Teaching and Learning
Learning Outcomes

By the end of this session, you’ll be able to …

• Describe some elements of the learning cycle presented.

• List some classroom assessment tools which you are not using but could improve learning in your courses.

• Identify the benefits of interactive-engagement and dare to give these activities a try.
What is assessment (of student learning)?

1. Establish goals for student learning (expressed as learning outcomes)
2. Determine the evidence: the work students will do to demonstrate their learning
3. Design & provide intentional learning experiences (curriculum & pedagogy)
4. Gather & review evidence of student learning
5. Draw conclusions about student learning achievements in the aggregate
6. As necessary, act on the results to improve student achievement of learning goals

Hybrid of Suskie (2009), the CIRTL Teaching-as-Research (TAR) framework, and Backward Design (McTighe & Williams, 1998)
What are the class learning outcomes?

Statements that focus on the outcomes we expect of students to do when they complete the course/ or class lesson

**BLOOM\'S TAXONOMY**

- **EVALUATION**
  - Assessing theories; Comparison of ideas; Evaluating outcomes; Solving; Judging; Recommending; Rating

- **SYNTHESIS**
  - Using old concepts to create new ideas; Design and Invention; Composing; Imagining; Inferring; Modifying; Predicting; Combining

- **ANALYSIS**
  - Identifying and analyzing patterns; Organisation of ideas; recognizing trends

- **APPLICATION**
  - Using and applying knowledge; Using problem solving methods; Manipulating; Designing; Experimenting

- **COMPREHENSION**
  - Understanding; Translating; Summarising; Demonstrating; Discussing

- **KNOWLEDGE**
  - Recall of information; Discovery; Observation; Listing; Locating; Naming

https://reflectionedu.files.wordpress.com/2012/05/blooms_taxonomy.jpg
Bloom's Taxonomy

6 Levels in the Cognitive Domain of the Taxonomy

1. Knowledge
   - Verbs: define, describe, identify, label, list, match, name, outline, recall, recognize, reproduce, select, state
   - Information: Remember previously learned material

2. Comprehension
   - Verbs: comprehend, condense, describe, discuss, distinguish, interpret, locate
   - Information: Grasp the meaning of material

3. Application
   - Verbs: apply, carry out, construct, demonstrate, operate, produce, use
   - Information: Use learning in new and concrete situations

4. Analysis
   - Verbs: analyze, compare, contrast, differentiate
   - Information: Understand both the content and structure of material

5. Synthesis
   - Verbs: compile, create, develop, generalize, integrate, propose
   - Information: Formulate new structures from existing knowledge and skills

6. Evaluation
   - Verbs: appraise, assess, criticize, defend, evaluate, justify, support
   - Information: Judge the value of material
### Verbs useful for stating learning outcomes

#### Action Words for Bloom’s Taxonomy

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Understand</th>
<th>Apply</th>
<th>Analyze</th>
<th>Evaluate</th>
<th>Create</th>
</tr>
</thead>
<tbody>
<tr>
<td>define</td>
<td>explain</td>
<td>solve</td>
<td>analyze</td>
<td>reframe</td>
<td>design</td>
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<tr>
<td>identify</td>
<td>describe</td>
<td>apply</td>
<td>compare</td>
<td>criticize</td>
<td>compose</td>
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<td>describe</td>
<td>interpret</td>
<td>illustrate</td>
<td>classify</td>
<td>evaluate</td>
<td>create</td>
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<tr>
<td>label</td>
<td>paraphrase</td>
<td>modify</td>
<td>contrast</td>
<td>order</td>
<td>plan</td>
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<tr>
<td>list</td>
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<td>use</td>
<td>distinguish</td>
<td>appraise</td>
<td>combine</td>
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<td>classify</td>
<td>calculate</td>
<td>infer</td>
<td>judge</td>
<td>formulate</td>
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<td>state</td>
<td>compare</td>
<td>change</td>
<td>separate</td>
<td>support</td>
<td>invent</td>
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<tr>
<td>match</td>
<td>differentiate</td>
<td>choose</td>
<td>explain</td>
<td>compare</td>
<td>hypothesize</td>
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<tr>
<td>recognize</td>
<td>discuss</td>
<td>demonstrate</td>
<td>select</td>
<td>decide</td>
<td>substitute</td>
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<tr>
<td>select</td>
<td>distinguish</td>
<td>discover</td>
<td>categorize</td>
<td>discriminate</td>
<td>write</td>
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<td>extend</td>
<td>experiment</td>
<td>connect</td>
<td>recommend</td>
<td>compile</td>
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<tr>
<td>locate</td>
<td>predict</td>
<td>relate</td>
<td>discriminate</td>
<td>summarize</td>
<td>construct</td>
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<td>develop</td>
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<td>contrast</td>
<td>sketch</td>
<td>order</td>
<td>convince</td>
<td>generalize</td>
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<tr>
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<td>convert</td>
<td>complete</td>
<td>order</td>
<td>defend</td>
<td>modify</td>
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<td>reproduce</td>
<td>demonstrate</td>
<td>construct</td>
<td>point out</td>
<td>estimate</td>
<td>organize</td>
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<td>prioritize</td>
<td>factor</td>
<td>produce</td>
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<td>tell</td>
<td>express</td>
<td>interpret</td>
<td>divide</td>
<td>generalization</td>
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<td>copy</td>
<td>identify</td>
<td>manipulate</td>
<td>order</td>
<td>predict</td>
<td>rewrite</td>
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<tr>
<td>discover</td>
<td>indicate</td>
<td>paint</td>
<td>predict</td>
<td>rank</td>
<td>role-play</td>
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<tr>
<td>duplicate</td>
<td>infer</td>
<td>prepare</td>
<td>break down</td>
<td>score</td>
<td>adapt</td>
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<tr>
<td>enumerate</td>
<td>relate</td>
<td>produce</td>
<td>calculate</td>
<td>test</td>
<td>arrange</td>
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<tr>
<td>listen</td>
<td>restate</td>
<td>report</td>
<td>conclude</td>
<td>select</td>
<td>anticipate</td>
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<tr>
<td>observe</td>
<td>select</td>
<td>teach</td>
<td>correlate</td>
<td>test</td>
<td>arrange</td>
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<tr>
<td>omit</td>
<td>translate</td>
<td>act</td>
<td>criticize</td>
<td>argue</td>
<td>assemble</td>
</tr>
<tr>
<td>read</td>
<td>ask</td>
<td>administer</td>
<td>deduce</td>
<td>argue</td>
<td>choose</td>
</tr>
<tr>
<td>recite</td>
<td>cite</td>
<td>articulate</td>
<td>deduce</td>
<td>decide</td>
<td>choose</td>
</tr>
<tr>
<td>record</td>
<td>discover</td>
<td>chart</td>
<td>devise</td>
<td>consider</td>
<td>collaborate</td>
</tr>
<tr>
<td>report</td>
<td>generalize</td>
<td>collect</td>
<td>diagram</td>
<td>critique</td>
<td>collaborate</td>
</tr>
</tbody>
</table>

Activity: Analyze a Learning Outcome (L.O.)

Choose one of the following two L.O.s:

1) Analyze it in relation the criteria for useful L.O.s.
2) Propose revisions as you feel appropriate.
3) Share your analysis with the rest.

L.O. 1: At the conclusion of this course, students will understand basic statistical analysis.

L.O. 2: At the conclusion of this course, students will be familiar with academic writing and speaking practices.
Checklist for creating learning outcomes:

☐ Does the learning outcome identify what students will be able to do after the topic is covered?
☐ Is it clear how you would test achievement of the learning outcome?
☐ Do chosen verbs have a clear meaning?
☐ Is the verb aligned with the level of cognitive understanding expected of students? Could you expect a higher level of understanding?
☐ Is the terminology familiar/common? If not, is knowing the terminology a goal?
☐ Is it possible to write the outcome so it is relevant and useful to students (e.g. connected to their everyday life, or does it represent a useful application of the ideas)?
Key Class Assessment Activities

- Wk 1: Needs Assessment
- Week 4 to 8: Mid-Course Feedback
- Final Course Evaluation

Fall Semester
Needs Assessment

- Pre/ Post Test
- Entry Survey

Prior Knowledge
Attitudes
Values

Your class expectations:
OH, studying time, specific requirements, etc.

Campus Resources:
Library/ Tutoring/ Mentoring/ STEM Center, etc.
Mid-Course Feedback

• It will benefit the same students who provide the feedback (Bullock, 2003).
• It provides opportunities for students to comment on specific behaviors or pedagogical strategies that are not covered by the standard end-of-semester evaluation questions.
• It provides the potential to improve end-of-semester evaluations and increase student exam performance (Overall and Marsh, 1979).
• Students respond positively when their comments result in changes to the course, leading to improved student attitudes about the class and/or instructor (Keutzer, 1993).
Assessment Process: An Example

1. **Outcome**: Write a technical report
2. **Evidence**: Technical reports
3. **Design**:
   - Write reports weekly guided by rubric.
   - Detailed feedback provided consistent with rubric.
   - Track students’ use of feedback.
4.-6. **Gather evidence, draw conclusions, act on results**:
   - Mid-semester: examines students improvements, finds students using feedback are improving more than others.
   - Shares this with class to motivate use of feedback to improve.
   - Continues to provide detailed feedback through multiple avenues.

6. **As necessary, act on the results to improve student achievement of learning goals**
5. **Draw conclusions about student learning achievements in the aggregate**
4. **Gather & review evidence of student learning**
3. **Design & provide intentional learning experiences (curriculum & pedagogy)**
2. **Determine the evidence: the work students will do to demonstrate their learning**
1. **Establish goals for student learning (expressed as learning outcomes)**
Assessment as planning cycle

1. Setting goals
2. Developing strategies
3. Outlining tasks
4. Evaluating success
Assessment as pedagogy

Instructional activities selected to

- facilitate development of and
- to reveal (to the teacher and the students)

student learning in relation to instructional goals.

☑ Evidence of student learning is abundant.

☑ Harvest it intentionally and strategically.
Relationship of grading & assessment

**Grading**: Summarizes learning demonstrated by an *individual* student, with feedback providing insight into and supporting his/her *individual* learning.
Relationship of grading & assessment

Assessment: Summarizes learning demonstrated by a population of students to provide insights into how well the educational opportunity (class, course, program) is serving students as a whole.

Ex. What might this tell us?

Results from a mid-semester research paper:

- 60% of students scored as proficient or better in use of citations and evidence in argument.
- 40% scored below proficient.
Assessment is “teaching to the test” (Suskie, 2009)

Requires

- Assessments that are designed to be worth teaching to
- Intended learning outcomes that are higher level
- Opportunities for practice with specific, targeted feedback to students on what doing well, and what to improve
Essentially assessment is a form of research

Assessment paradigm

- Outcome
- Instructional Activities/Curriculum
- Collect & analyze evidence of student learning. Draw conclusions, revise instruction or outcomes.

Research paradigm

- Hypothesis: what students will be able to do
- Experimental Design
- Gather data and draw conclusions about hypothesis
Assessment is “action research” (Suskie, 2009)

Assessment as Action Research*

- Specific to local environment & student body
- Intended for local improvement
- Data/evidence are sufficiently valid and reliable so as to be “good enough,” “trustworthy enough” to act on

Empirical Research

- Pursue generalizable results (theories)
- High quality design and data to meet test of peer review

*Suskie, 2009
Classroom Assessment Techniques (CATs)

- Minute Paper
- Chain Notes
- Memory Matrix
- Directed paraphrasing
- One sentence summary
- Exam Evaluations
- Application cards
- Student-generated test questions

Large and Small Classes Assessment Tools

Creating: **Group work**

Evaluating: **Debate**

Analyzing: **Clicker questions**

Applying: **Student Presentations – Pop quizzes**

Understanding: **Role playing / Just-in-time teaching**

Remembering: **Memory Matrix**

Challenges to Implementing Interactive Activities

- Students resistance to participation (e.g. stop coming to class, start discussing their weekend plans)
- Expectations of content coverage
- Lack of instruction/instructor time
- Class size, or room layout
- Influence on teaching evaluations
- Additional time for curriculum (re)design
Quantifying student behavioral engagement based on teaching practices in a large class

Results from a large introductory oceanography course:
Classroom observations were conducted during 27 lectures in a first year Oceanography course with an enrollment of 170 students and two course instructors. The observer sat in one of nine sections in the classroom, and obtained observations from each section at least three times in the semester. A total of 720 engagement observation points were recorded through the semester.

Figure 1: Student engagement over a lecture period based on teaching activities

Data from a typical class period reveal activities that are more and less engaging for students (Figure 1). The instructor also gets a snapshot of what student engagement looked like over the 50-minute lecture period and can easily see where to make changes.

Figure 2: Student engagement based on instructional activity averaged over the semester for each instructor

Overall observation data show that student engagement is strongly correlated to teaching practices. Two instructors with varying teaching experience show the same trends in student engagement based on teaching practices. On average, the most engaging activity is clicker questions and clicker question follow-up and the least engaging are instructor lecture, summaries, and learning goals.
### TABLE 1

**Descriptions of student in-class behaviors that indicate they are engaged.**

<table>
<thead>
<tr>
<th>Engaged</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Listening</strong></td>
<td>Student is listening to lecture. Eye contact is focused on the instructor or activity and the student makes appropriate facial expressions, gestures, and posture shifts (i.e., smiling, nodding in agreement, leaning forward).</td>
</tr>
<tr>
<td><strong>Writing</strong></td>
<td>Student is taking notes on in-class material, the timing of which relates to the instructor’s presentation or statements.</td>
</tr>
<tr>
<td><strong>Reading</strong></td>
<td>Student is reading material related to class. Eye contact is focused on and following the material presented in lecture or preprinted notes. When a question is posed in class, the student flips through their notes or textbook.</td>
</tr>
<tr>
<td><strong>Engaged computer use</strong></td>
<td>Student is following along with lecture on computer or taking class notes in a word processor or on the presentation. Screen content matches lecture content.</td>
</tr>
<tr>
<td><strong>Engaged student interaction</strong></td>
<td>Student discussion relates to class material. Student verbal and nonverbal behavior indicates he or she is listening or explaining lecture content. Student is using hand gestures or pointing at notes or screen.</td>
</tr>
<tr>
<td><strong>Engaged interaction with instructor</strong></td>
<td>Student is asking or answering a question or participating in an in-class discussion.</td>
</tr>
</tbody>
</table>

### TABLE 2

**Descriptions of student in-class behaviors that indicate they are disengaged.**

<table>
<thead>
<tr>
<th>Disengaged</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Settling in/ packing up</strong></td>
<td>Student is unpacking, downloading class material, organizing notes, finding a seat, or packing up and leaving classroom.</td>
</tr>
<tr>
<td><strong>Unresponsive</strong></td>
<td>Student is not responsive to lecture. Eyes are closed or not focused on instructor or lecture material. Student is slouched or sleeping, and student’s facial expressions are unresponsive to instructor’s cues.</td>
</tr>
<tr>
<td><strong>Off-task</strong></td>
<td>Student is working on homework or studying for another course, playing with phone, listening to music, or reading non-class-related material.</td>
</tr>
<tr>
<td><strong>Disengaged computer use</strong></td>
<td>Student is surfing web, playing game, chatting online, checking e-mail.</td>
</tr>
<tr>
<td><strong>Disengaged student interaction</strong></td>
<td>Student discussion does not relate to class material.</td>
</tr>
<tr>
<td><strong>Distracted by another student</strong></td>
<td>Student is observing other student(s) and is distracted by an off-task conversation or by another student’s computer or phone.</td>
</tr>
</tbody>
</table>
Suggested Instructional Strategies for Use with Each Level of Bloom's Taxonomy

**Knowledge**
- define
- repeat
- record
- list

**Comprehension**
- translate
- restate
- discuss
- describe
- recognize
- explain
- express
- identify

**Application**
- interpret
- apply
- employ
- use
- demonstrate
- dramatize
- practice
- illustrate
- operate
- schedule
- shop
- sketch

**Analysis**
- distinguish
- analyze
- differentiate
- appraise
- calculate
- experiment
- test
- compare
- contrast
- criticize
- diagram
- inspect
- debate
- inventory
- question
- relate

**Synthesis**
- compose
- plan
- propose
- design
- formulate
- arrange
- collect
- construct
- create
- set up
- organize
- manage
- prepare

**Evaluation**
- judge
- appraise
- evaluate
- rate
- compare
- value
- revise
- score
- select
- choose
- assess
- estimate
- measure
Learning Outcomes

By the end of this session, you’ll be able to …

• Describe some elements of the learning cycle presented.

• List some classroom assessment tools which you are not using but could improve learning in your courses

• Identify the benefits of interactive-engagement and dare to give these activities a try.
Resources

• Assessment at UC Merced: [http://assessment.ucmerced.edu/](http://assessment.ucmerced.edu/)
  This website provides assessment related information for academic and non-academic program on campus.
• Carl Wieman Science Education Initiative at the University of British Columbia: [http://cwsei.ubc.ca/](http://cwsei.ubc.ca/)
  Resources aim at improving undergraduate science education. Consider the following tools: Classroom Observation Protocol, Teaching Practices Inventory, Student Engagement Observation Protocol and Learning Attitudes about Science Surveys
• Writing Great Clicker Questions: [Faculty Workshop cwsei.ubc.ca/resources/](http://cwsei.ubc.ca/resources/)
• Resources by Discipline: University of Michigan, CRLT: [http://www.crlt.umich.edu/tstrategies/disciplinaryresources](http://www.crlt.umich.edu/tstrategies/disciplinaryresources)
• CRTE: Teaching Resources: [http://crte.ucmerced.edu/](http://crte.ucmerced.edu/)
• SATAL Program: Offer trained undergraduates who can assist you with data collection, analyzes and reporting.
Many thanks to….

- Laura Martin for sharing the assessment cycle slides
- Belinda Braunstein’s feedback during presentation rehearsal.
# 25+ question stems framed around the early, non-revised Bloom's Taxonomy

## CRITICAL THINKING SKILLS

<table>
<thead>
<tr>
<th>Level</th>
<th>Domain</th>
<th>Question Stems</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge</td>
<td>Identify, locate, define, recall, spell, tell, underline</td>
</tr>
<tr>
<td>2</td>
<td>Comprehension</td>
<td>Explain, interpret, put in order, restate, summarize, translate</td>
</tr>
<tr>
<td>3</td>
<td>Application</td>
<td>Apply, compute, conclude, construct, demonstrate, draw, give an example, illustrate, make, operate, show, solve, state a rule or principle, use</td>
</tr>
<tr>
<td>4</td>
<td>Analysis</td>
<td>Analyze, categorize, contrast, debate, deduct, determine the factors, examine, differentiate, dissect, distinguish, specify</td>
</tr>
<tr>
<td>5</td>
<td>Synthesis</td>
<td>Change, compose, construct, create, design, find an unusual way, formulate, generate, invent, originate, predict, produce, rearrange, reorganize, revise, suggest, support, write</td>
</tr>
<tr>
<td>6</td>
<td>Evaluation</td>
<td>Appraise, choose, compare, decide, defend, evaluate, give your opinion, judge, justify, prioritize, rank, rate, select, support, value</td>
</tr>
</tbody>
</table>

Students at a variety of achievement levels may inform the class outcomes

**A students**: verify that students get the right answer for the right reasons

**B and C students**: retain some misunderstandings that are useful as distracters

**D students**: look for non-content clues to the right answer
### Example of Learning Outcomes

<table>
<thead>
<tr>
<th>UC Merced Principles</th>
<th>Course Goals</th>
<th>Course Learning Outcomes</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientific Literacy</td>
<td>To provide an introduction to the field of social epidemiology, the major theories, concepts, and perspectives.</td>
<td><strong>Describe</strong> how social and environmental factors affect health outcomes, including how risk factors are arrayed across different social conditions.</td>
<td>Term paper, exams, reading summaries, quizzes</td>
</tr>
<tr>
<td>Scientific Literacy Communication</td>
<td>To learn how health outcomes and risk factors are arrayed across different social conditions and social systems.</td>
<td>(a) <strong>Integrate</strong> different perspectives, research, and skills discussed in class to explain group differences in health and well-being. (b) In writing, clearly <strong>analyze</strong> these differences in health and well-being.</td>
<td>Term paper, exams, reading summaries</td>
</tr>
</tbody>
</table>
Active Learning “Works”...
What Are We Measuring?

- Factual knowledge
- Transferable problem solving skills (Hake, R. 1997)
- Relevant skills
- Students’ attitudes
- Student retention
Biology CLASS statements designed to distinguish novice and expert beliefs

Survey (8-10 minutes)

1. When I am solving a biology problem, I try to decide if my answer makes sense.
   Strongly Disagree 1 2 3 4 5 Strongly Agree
   □ □ □ □ □
   (ока не ответили)

2. I think about the biology I experience in everyday life.
   Strongly Disagree 1 2 3 4 5 Strongly Agree
   □ □ □ □ □
   (ока не ответили)

3. After I study a topic in biology and feel that I understand it, I have difficulty applying that information to answer questions on the same topic.
   Strongly Disagree 1 2 3 4 5 Strongly Agree
   □ □ □ □ □
   (ока не ответили)

4. Knowledge in biology consists of many disconnected topics.
   Strongly Disagree 1 2 3 4 5 Strongly Agree
   □ □ □ □ □
   (ока не ответили)

- Statements are based on the physics CLASS (Adams et al., 2004)
- Student interviews on statements were conducted for clarity of interpretation (n=15)
- Experts have 80% or greater agreement on 34 of 44 statements
- Student responses are compared with experts
Example of a learning outcome

Syllabus topic: Pedigree Analysis

Example of a course learning outcome
After completing this course, students should be able to:

Analyze phenotypic data and deduce possible modes of inheritance (e.g. dominant, recessive, autosomal, X-linked, cytoplasmic) from family histories.

Sample of class learning outcomes
Draw a pedigree based on information in a story problem.
Calculate the probability that an individual in a pedigree has a particular genotype.
Define the terms “incomplete penetrance,” “variable expressivity,” and “sex-limited phenotype,” and explain how these phenomena can complicate pedigree analysis.
The pre/post assessment is different from other tests

Assessment could be multiple-choice questions that address the course learning outcomes.

Jargon is used minimally in this assessment.

Assessment is given pre and post to measure learning gains.

The incorrect answers are designed to be attractive to students who do not fully understand the concepts.
Differences between novice and expert learners concerning their beliefs about science

<table>
<thead>
<tr>
<th>Novice</th>
<th>Expert</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated pieces of information</td>
<td>Coherent framework of concepts</td>
</tr>
<tr>
<td>Handed down by authority</td>
<td>Describes nature Established by experiments</td>
</tr>
<tr>
<td>No connection to the real world</td>
<td></td>
</tr>
<tr>
<td>Pattern matching to memorized recipes</td>
<td>Use concept-based strategies. Widely applicable.</td>
</tr>
</tbody>
</table>

(adapted from David Hammer, 2000).
Planning cycle applicable at any learning experience

1. Establish goals for student learning (expressed as learning outcomes)
2. Determine the evidence: the work students will do to demonstrate their learning
3. Design & provide intentional learning experiences (curriculum & pedagogy)
4. Gather & review evidence of student learning
5. Draw conclusions about student learning achievements in the aggregate
6. As necessary, act on the results to improve student achievement of learning goals

- Given day’s class
- Course
- Degree Program