What do you want them to learn today?

WRITING LEARNING GOALS TO DRIVE INSTRUCTION & ASSESSMENT

Dr. Stephanie V. Chasteen  
Dr. Kathy Perkins  
Physics Department  
&  
Science Education Initiative  
Univ. of Colorado at Boulder

http://colorado.edu/sei

While you’re coming in, please read “The Frustrated Student” in your handouts
Our approach to course transformation

- What *should* students learn?
- What *are* students learning?

**Establish learning goals**

**Using Research & Assessment**

**Faculty & Staff**

- Which instructional approaches improve student learning?

**Apply research-based teaching techniques.**

**Measure progress!**
At the end of this workshop

You will be able to...

- Develop and communicate your learning goals clearly for a given topic
- Characterize learning goals or assessments using Bloom’s Taxonomy
- Recognize the value of aligning assessments with goals
Let’s get our brains on topic

CASE STUDY: Frustrated student

Think – pair – share

✓ What issues might be contributing to this situation?

✓ What suggestions do you have for the professor?
Example... consider finals

For a typical Physics 1 course are Grades and the Final Exam effective forms of evaluation of the course?

a) Yes
b) No (What does “effective” mean?)
c) It Depends

In order to care about assessment outcomes, you first need to establish course goals. What do you want to accomplish?
Instruction without goals....

Ready?

Fire!

Aim.
Outcomes should drive assessment & instruction

Atkin, Black, & Coffey 2001; Otero & Nathan 2008
But how do we measure outcomes?

- How do you know when you know something?
- How do you know when your students know something?
- How do your students know when they know something?

**Buzzword:** Metacognition
People often don’t know what they don’t know

AND/OR
Think they know something but don’t!

MISCONCEPTIONS
Private Universe

(http://www.learner.org/resources/series28.html)
Misconceptions can drive instruction

If a camera crew making a documentary on student misconceptions were to question your students at the end of your course or the end of your degree program, what would you be most embarrassed to find out that they didn’t know?

These should be your top goals
Learning goals

- **Definition:** What students should be able to do after completing a course
- **Requirement:** Must be measurable
  → assessment and goals tightly linked

- ✓ Your goals should reflect what you value in student learning
- ✓ Often, students never know what your goals are!
Learning Goals are different than a syllabus

Syllabus/ Topic List
• Material covered (and time spent)

Learning goals:
Outcome and student oriented:
• Identifies what students will be able to do as a result of learning
• Defines what students are expected to learn

Learning Goals (for a whole course) can be broad. At the topic or lecture level, the learning objectives should be more specific
**Journalism:**
Students should be able to contrast press freedom in the United States with that of other countries around the world.

**Genetics**
Students should be able to calculate the probability that an individual in a pedigree has a particular genotype.

Courtesy Sandra Fish and Michelle Smith
Goals at different levels

Course-scale learning goals
(~5 to 10 per course)

Topic-scale learning goals
(~2-5 per topic)

Class-scale learning goals
(~2-3 per class period)

Course: Students should be able to contrast press freedom in the United States with that of other countries around the world.

Topic: Students should be able to calculate the probability that an individual in a pedigree has a particular genotype.

Consistent & aligned
<table>
<thead>
<tr>
<th>Course-level learning goal</th>
<th>Specific learning goal</th>
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</thead>
<tbody>
<tr>
<td><strong>Content:</strong> Demonstrate how meiosis leads to diversity in the next generation</td>
<td>Predict the probability of generating sperm and egg cells with specific chromosomal makeup, and explain how these cells are produced</td>
</tr>
<tr>
<td><strong>Skills:</strong> Become better problem solvers</td>
<td></td>
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</tbody>
</table>
## Intro Astronomy

<table>
<thead>
<tr>
<th>Course-level learning goal</th>
<th>Class-scale learning goal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Content:</strong> Explain the role of natural forces in the universe</td>
<td>Analyze the phases of the moon by using computer simulations and constructing a model.</td>
</tr>
<tr>
<td><strong>Skills:</strong> Interpret simulations and data</td>
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</table>

### Moon Phases Diagram

- NM: New Moon
- WCH1: Waxing Crescent Moon
- WCH2: Waxing Half Moon
- VH1: Full Moon
- VH2: Waning Half Moon
- SQM: Waning Crescent Moon
- WCH1: Waxing Crescent Moon
- WCH2: Waxing Half Moon
- VH1: Full Moon
- VH2: Waning Half Moon
- SQM: Waning Crescent Moon
But what does “understanding” mean?

How do we define goals?

1. **At what level** do we want students to understand something?

2. **What are the different types of knowledge** we want students to have?
#1: Levels of knowledge
Bloom’s Taxonomy, 1956

What level of understanding do you want them to gain?

- Knowledge
- Comprehension
- Application
- Analysis
- Synthesis & Evaluation

Higher cognitive orders

Lower cognitive orders

Higher-level cognitive skills

Lower-level cognitive skills
EXERCISE #2: Three Little Pigs

- Complete the “Three Little Pigs” worksheet
- If you’re not familiar with the fairytale, ask us

5 minutes
#2: Types of knowledge (learning goals)

**FACTS:**
What type of understanding do you want them to gain?
Terminology, information, details

**CONCEPTS**
Classifications, categories, principles, models, reasoning.
Analyze, explain, and predict the world around you

**PROCEDURES:**
Skills, techniques, methods, problem-solving.
Thinking like a scientist: Use alternative representations, compare and contrast, strategize, justify, design an experiment, create a graph.

**METACOGNITIVE**
Self-awareness about what helps you learn; studying & learning strategies.

**AFFECTIVE (attitudes & beliefs):**
Appreciate, enjoy, value. Recognize that the behavior of the world around you is not magical and mysterious, but rather can be understood and predicted using certain fundamental principles.

Handout
EXERCISE #3: Exam Dissection

- Use 4 questions on one of your exams
- Work alone or in pairs
- What type of knowledge is this question testing?
- If you finish – what is the Bloom’s Level of this question?

<table>
<thead>
<tr>
<th>Question #</th>
<th>Type of knowledge (facts, concepts, procedures, metacognitive, beliefs)</th>
<th>(Optional) Bloom’s Level?</th>
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5 minutes
Attitudes and Beliefs

Survey (CLASS) to assess the “hidden curriculum” - beliefs about physics and learning physics

Examples:
- “I study physics to learn knowledge that will be useful in life.”
- “To learn physics, I only need to memorize solutions to sample problems”

Can we affect students’ attitudes & beliefs about physics?

Check-list for creating **class-scale** learning goals:

- ✓ Is goal expressed in terms of **what the student will achieve** or be able to do?
- ✓ Is the **Bloom’s level** of the goal aligned with your actual expectations?
- ✓ Is the goal **well-defined**? Is it clear how you would measure achievement?
- ✓ Do chosen verbs have a **clear** meaning?
- ✓ Is **terminology familiar/common**? If not, is the terminology a goal?
- ✓ Is it **relevant and useful** to students? (e.g. connected to their everyday life OR does it represent a useful application of the ideas).
## Intro Physics

<table>
<thead>
<tr>
<th>Original L.G.</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understand how energy, frequency and wavelength are related.</td>
<td>Higher level. Defines understanding. Encourages critical thinking as well as memorization.</td>
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</table>

<table>
<thead>
<tr>
<th>New L.G.</th>
<th></th>
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<tbody>
<tr>
<td>Compare and contrast electromagnetic waves (e.g., gamma and radio) in terms of energy, wavelength, frequency, and relevant applications.</td>
<td></td>
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</table>
Goals can be revised for clarity or to address higher goal

**Journalism**

<table>
<thead>
<tr>
<th>Learning Goal</th>
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</thead>
<tbody>
<tr>
<td>Understand the essential features of a newspaper article.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Revised Learning Goal</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analyze and contrast the structures of a newspaper article, a news broadcast, and an online news site</td>
<td>Operationalized. Higher level goal. Encourages comparison. Requires application of knowledge.</td>
</tr>
</tbody>
</table>

Higher level of Bloom’s: Write a mission statement for your career as a journalist.
Work on your learning goals with your partner

- **Individually**, using one exam question that you brought with you, write a topic-level learning goal that this question would assess. (Keep a copy of this first try).

- **Share your learning goal with your partner and/or facilitators**, and use your white boards to work on revising each LG.
  - Compare the current wording of the LG to the guidelines we have provided (identify the “level” of this LG, and whether it is too broad or too narrow).
  - Discuss how the LG could be rewritten to better state your true goal.

- Then, for the topic you have been discussing, write a LG that is **one or more level(s) higher** on Bloom’s.

**Note:** You can use the verbs and model questions on the “Bloom’s Taxonomy handout to help you.”
Share the process of creating learning goals with your group

• What was the exam question you started with?
• What was your original LG?
• How did the goal change through discussion?
• What was difficult about this process and what did you learn through your discussion?

• Questions?
Now you’ve got learning goals. How do you integrate this with your course?

- When would you write your learning goals?
- When do you refer to your written learning goals?
- How does this help you decide what to do in your class time?
- How does this help you decide what to put on your homework?
How do we align goals and assessment?

Outcomes should drive assessment & instruction

Atkin, Black, & Coffey 2001; Otero & Nathan 2008
What assessments should I use?

To find the answer to that, you need to consider:

- What are assessments that align with my learning goals and key concepts?
- What kinds of outcomes can I measure?
Why do we assess / question?

• Gather evidence on student learning (evaluation)
• Improve a course
• Improve our teaching
• Improve society (?)
• Get feedback on student understanding
• Elicit misconceptions
• Guide your own instructional decisions
• Make expectations clear to students
• Provide feedback to students
• Give students an opportunity to gauge their progress
• Help guide student studying and learning behavior
Why care about assessment?

Assessment is more than grades, it is feedback for students and instructors and it drives student learning

(National Institute for Science Education, 1999)

Ongoing assessment plays a key role – possibly the most important role – in shaping classroom standards and increased learning gains”

- Black and Wiliam, 1998
When can we assess students?

- **Course-scale:** Before or after a course.
- **Class-scale:** Before, during, or at the end of a class

A bit of Jargon:
Formative vs. Summative Assessment

See take-home assignment, “Grading”
## What are some assessment methods?

<table>
<thead>
<tr>
<th><strong>FORMATIVE, IN-CLASS</strong></th>
<th><strong>SUMMATIVE EVALUATION</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Concept Tests / Clickers</td>
<td>✓ Quizzes</td>
</tr>
<tr>
<td>✓ Minute Papers</td>
<td>✓ Exams</td>
</tr>
<tr>
<td>✓ Just in Time Teaching</td>
<td>✓ Oral presentations</td>
</tr>
<tr>
<td>✓ Listening to student discussion in class</td>
<td>✓ Poster symposia</td>
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<tr>
<td>✓ Weekly / Daily Surveys</td>
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<tr>
<td>✓ White-boarding activities</td>
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<td>✓ In-class work / Tutorials</td>
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<td>✓ Case studies</td>
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<tr>
<td>✓ Ranking / ordering tasks</td>
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<tr>
<td>✓ Think-pair-share.</td>
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<tr>
<td>✓ Student-designed reading assessments</td>
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<table>
<thead>
<tr>
<th><strong>OTHERS</strong></th>
<th><strong>SUMMATIVE FEEDBACK</strong></th>
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<tbody>
<tr>
<td></td>
<td>✓ Conceptual surveys</td>
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<tr>
<td></td>
<td>✓ Attitude surveys</td>
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</table>

<table>
<thead>
<tr>
<th><strong>FORMATIVE, OUT OF CLASS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Homework</td>
</tr>
<tr>
<td>✓ Discussion boards</td>
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</table>
It is very important to learn about traxoline. Traxoline is a new form of zionter. It is montilled in Ceristanna. The Ceristannians found that they could gristerlate large amounts of fervon and then bracter it to quasel traxoline. This new, more efficient bracterillation process has the potential to make traxoline one of the most useful products within the molecular family of lukizes snezlaus.

**QUIZ:**
1. What is traxoline?
2. Where is it montilled?
3. How is traxoline quaseled?
4. Why is traxoline important?

Assessments communicate your intent:
If you test them on facts, that is what they will study
EXERCISE #2: Frustrated Student

- Read the case study
- Discuss questions in groups of 4-5

• What issues might be contributing to this situation?
• Do the assessments give the student any feedback about what they understand while they are learning about this topic?
• What do the assessments motivate the student to learn? What effect this professor’s assessment will have on student behavior for the next test? Do you think that was the intention?
• What suggestions do you have for the professor?
• Have you faced a similar challenge?

Adapted from Handelsman, Miller & Pfund, 2007
The various goals of questioning or assessing during class

**BEFORE**
Setting up instruction
- Motivate
- Discover
- Predict outcome
- Provoke thinking
- Assess prior knowledge

**DURING**
Developing knowledge
- Check knowledge
- Application
- Analysis
- Evaluation
- Synthesis
- Exercise skill
- Elicit misconception

**AFTER**
Assessing learning
- Relate to big picture
- Demonstrate success
- Review or recap
- Exit poll

Credit: Rosie Piller and Ian Beatty.
## EXERCISE #3: Compare and Contrast

- Work with 1-2 others to compare and contrast what students experience during two different types of assessment activities

<table>
<thead>
<tr>
<th>Case 1</th>
<th>Case 2</th>
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<tbody>
<tr>
<td>Each week, students are assigned a reading. All students take a 10-minute quiz that tests factual knowledge. Quizzes are handed in for points.</td>
<td>Each week, students are assigned a reading. All students generate a diagram or concept-map to illustrate the concept from the reading on their own. They explain their figure to each other in small groups for 10 minutes at the start of class. After discussion, they write a one-minute paper to explain what they learned. Diagrams and papers are handed in for points.</td>
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</tbody>
</table>

| How does the assessment motivate students to learn the material or figure out the concepts they don’t understand? | |
| How does the assessment capitalize on the diversity of learners? | |
| Does the assessment help students gauge what they know or how well they understand the key learning goals? | |
| Does the assessment build skills in giving and receiving critical feedback (learning how to learn)? | |
| Write your own questions here: | |
LG:
Recognize equilibrium points on a plot of potential energy, U, and determine if these points are stable given the function U(x).

Assessment:
Below is a plot of potential energy in Joules, of a particle free to move in 2D.

For which of these points (A-F) is the particle in stable equilibrium? Please explain how you arrived at that answer.
Alignment – an example:

Broader Learning goals:
• Use graphs as part of thought processes
• Recognize equilibrium points & determine if stable

Measurable Outcomes
Interpret graphs of potential energy
Predict behavior

Formative Assessment (Instruction)
Tutorial with topographic maps. Where will dislodged boulder roll? Relate to U.

Summative Assessment (Exams)
Which of these points is stable? Why?

See take-home exercise: Alignment
Where you goin’ to?

Atkin, Black, & Coffey 2001; Otero & Nathan 2008
Assessments communicate your intent

If you test them on facts, then that is what they will study

Does this process change how you think about your exams?
What should we do last?

A. Work on writing aligned questions, assessments, & instruction

B. Talk about grading
Use the exam questions and learning goals you used before to draft two aligned learning goals, activities, and assessments.

<table>
<thead>
<tr>
<th>Learning goal (where are you going?) From previous activity</th>
<th>Likely student prior knowledge/misconceptions (Where are you at?)</th>
<th>Example learning activity = formative assessment (How are you going to get there?)</th>
<th>Summative/formative assessment question (Are we there yet?) From exam or write a new one</th>
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</table>
EXERCISE #5. Case: Grading

Work in groups of 3-4 to discuss the case study and associated questions.

10 minutes
Questions?

Please fill out action plan and evaluation
Note the “take-home” exercises in packet

Much more at:

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www.colorado.edu/sei
phet.colorado.edu
www.colorado.edu/istem