What should students learn?

What are students learning now?

What improves student learning?

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What are we trying to accomplish? Do we know how well our courses “work”? Who “are the students”?

What is in our current courses? How do they link together?

Transforming courses: Active learning, Evidence based assessments
What is in our current courses? How do they link together? 

PROJECTS

Linking 1st year outcomes to upper levels

Chemistry analysis project

The big course map

3rd, 4th year course Learning Outcomes

M&I 3 areas

Ecology

Physiology

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Examine course notes for chemistry concepts.

Example: BIOL 361
- Laws of Thermodynamics
- Entropy
- Free energy and reaction coupling
- Free energy of equilibria
What are we trying to accomplish? Do we know how well our courses “work”? Who “are the students”?

PROJECTS

Investigating BIOL 201

Attitudinal survey

New Ecological Paradigm

Employer interviews
Student satisfaction interviews

BIOL 200: Student engagement and study habits (Support)

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What are we trying to accomplish? Do we know how well our courses “work”? PROJECTS

1. Chemistry Pre-test.
2. Student focus group interviews.
3. Follow-up Survey.
4. PRS question database (on-going).

Investigating BIOL201

Sunita Chowrira Botany
Jeff Richards Zoology
Wade Bingle M&I
Jared Taylor

800 students (4 sections).
Introduction to proteins, enzymes, ATP synthesis.

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What are we trying to accomplish? Do we know how well our courses “work”?

Follow-up Survey

Investigating BIOL201

Follow-up Survey Question Examples

Lectures cover previously learned material too often
The PRS questions are quite challenging
Lectures are useful for learning the Biology 201 material
What are we trying to accomplish? Do we know how well our courses “work”?

PROJECTS

Attitudinal survey

James Berger (Zoology)  Gulnur Birol (Biology and Skylight)
Jennifer Klenz (Biology)  Tamara Kelly (CWSEI-LS)
Michael Murphy (M&I)  George Spiegelman (M&I)
Kathy Nomme (Biology)  Joanne Nakonechny (Skylight)
Carol Pollock (Biology)  Ellen Rosenberg (Biology)
1st 2nd year instructors in BIOL111, 112, 121
Lots of 1st and 2nd year students

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What are we trying to accomplish? Do we know how well our courses “work”?

PROJECTS

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1. Piloted in BIOL111, BIOL112, BIOL121 term 1, 2007/08
2. Questions revised.
3. 2nd run BIOL112, BIOL121 BIOL201 term 2, 2007/08 (data available in June).
4. Collecting responses from experts.
5. Collaborating with CU Science Education Initiatives.
What are we trying to accomplish? Do we know how well our courses “work”?

Attitudinal survey

Results from BIOL 111

Learning Biology that is not directly relevant to or applicable to human health is not worth my time.

![Bar chart](chart.png)

- Disagree
- Neutral
- Agree

Fraction of responses

- Pre-
- Post-
- Expert

Life Sciences Carl Wieman Science Education Initiative
What are we trying to accomplish? Do we know how well our courses "work"?

**PROJECTS**

*Attitudinal survey*

Results from BIOL 111

It is important to study Biology to help find answers to societal problems.

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**Disagree** | **Neutral** | **Agree**

**Pre-** | **Post-** | **Expert**

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What are we trying to accomplish? Do we know how well our courses “work”? PROJECTS

New Ecological Paradigm
Faculty teaching ecology
Harald Yurk

Assess whether respondents view that their existence embedded is in the natural environment. Survey given to 1st, 3rd, 4th year students.


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1st year students

What are we trying to accomplish?
Do we know how well our courses “work”?

PROJECTS

New Ecological Paradigm

We are approaching the limit of the number of people the earth can support

Mean: 4.12*

The earth is like a spaceship with very limited room and resources

Mean: 3.96*

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Transforming courses
Active learning
Evidence based assessments
PROJECTS

Delivery methods in BIOL310

BIOL204 transformation

BIOL111 Transformation (Support)

BIOL121 Peer tutors

BIOL112 Learning Groups

The Homework Project

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The Goal: Shift the focus of class from passive to active learning.

Emphasis on problem solving and case studies.

Shift from memorizing anatomical detail to investigating relationship with more emphasis on physiology and biomechanics.
THE PLAN
1. Write learning outcomes for courses that use BIOL204 as a prerequisite.
2. Revise learning outcomes for BIOL204.
3. Write pre- and post- conceptual tests.
4. Write problems and develop case studies.
5. Write exams that evaluate the new learning outcomes.
6. Revise the lab manual to reflect the changes.
Goal: compare efficacy of: 1) lecture without group discussions and 2) group discussions without lecture.

Method: Analysis of homework for evidence of using conceptual context and interviews for attitudes towards delivery modes.
BIOL112 Learning Groups

Karen Smith M&I
Tracy Kion M&I
Julyet Benbasat M&I
Tamara Kelly
Gulnur Birol

Transforming courses
Active learning
Evidence based assessments
PROJECTS

Does a small group learning environment aid students’ conceptual understanding?

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1. 50 minutes sessions. Students in groups of ~5.
2. Work on conceptual problems derived from existing problem sets and exams.
3. TA-facilitated. 8 sessions.
4. Earn 3% (class participation) mark if attend all 8 sessions
5. ~ 300/1700 students volunteered
6. Analyze using comparison of marks, student focus group interviews, and surveys.
BIOL112 Learning Groups

Survey data

Transforming courses
Active learning
Evidence based assessments
PROJECTS

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- Improved Ability to Explain concepts
- Helped Understand Material in BIOL112
- Helped Understand BIOL112 concepts

Disagree
Neutral
Agree

% Disagree
% Neutral
% Agree
The “Homework Project”
Rosie Redfield Zoology
Tamara Kelly

Purpose:
To determine if weekly assignments improve students’ conceptual understanding of BIOL121 material.
To determine if online assignments that incorporate writing result in:
  - Increased conceptual understanding
  - Improved writing on short-answer exam questions
The global problem

Many students can’t write, and their science classes don’t help.

The local problem

BIOL 121 has no resources for teaching writing or for grading homework.
(no TAs and no tutorials)
9 sections, ~200 students/section
The question(s)

Does written rather than multiple-choice homework

1. Improve students writing ability?
2. Improve students’ understanding of concepts?

Previous experiments?

• Poor controls
• Small sample sizes
• Qualitative, not quantitative
The experiment

Rosie Redfield
Tamara Kelly (STLF)

~ 400 BIOL 121 students randomized into two groups:

- written-answer homework (n=189)
- multiple-choice homework (n=193)

- Mixed in the same two sections
- Same instructor (RR)
- Same everything except homework
- Weekly homework assignments delivered as Blackboard quizzes
- No tutorials or TAs
The homeworks

- same readings and instructions
- similar and identical questions

Some questions had written and MC versions.

Some questions were MC for both groups.

**Homework 13A (April 2-9)**

You’re encouraged to discuss the homework assignments with other students, but all answers you submit must have been written by you alone.

Answer the questions below in the Homework 13A Questions quiz.

1. Examine Figure 1 (in the separate Figures.pdf file, available on the Week 13 Learning Module) which summarizes the pre-farming and post-farming relationship between wild Pacific farmed salmon, and the sea louse *L. salmonis*.

2. Watch the video of fisheries biologist Alexandra Morton addressing the annual general meeting aquaculture corporation Cermac (provided as a link on the Week 13 Learning Module).

3. Read the commentary by Lisa Gross (provided as a pdf on the Week 13 Learning Module).

**Question 1.** Alexandra Morton does not explain to the Cermac AGM why she initially expected salmon farming would benefit wild salmon populations. Which of the listed explanation *(Multiple choice)*

- [ ] 
- [ ] 
- [ ]

**Question 2.** Consider the normal (pre-farm) life history of salmon and sea lice shown in the absence of salmon farms, what factors prevent wild juvenile salmon migrating to the exposed to sea lice? *(Answer in a few sentences.)*

Now consider results from the following studies.

**Research paper #1.** In 2004, Alexandra Morton and other researchers compared the lev

...
**Typical 2-version question:**

**Question:** In the absence of salmon farms, what factors prevent wild juvenile salmon from being exposed to sea lice when they are migrating to the sea?

**Writing group:** *Answer in a few sentences.*

**M-C group:** *Choose all that apply.*

1. Juvenile salmon do not encounter adult salmon until they reach the open sea.
2. *L. salmonis* does not survive in fresh water.
3. River flow and tides wash away lice released by returning adult salmon.
4. *L. salmonis* does not attach to juvenile salmon.
5. Adult salmon actively swim away from juvenile salmon.
Question 2. Consider the normal (pre-farm) life history of salmon and sea lice shown in Figure 1A. In the absence of salmon farms, what factors prevent wild juvenile salmon migrating to the sea from being exposed to sea lice? (Answer in a few sentences.)

Sample answer: When lice-infested adult salmon return to rivers to spawn, the fresh water kills their lice and the river flow and tides wash away any surviving lice. When juveniles hatch and migrate to the sea, they rarely encounter adult salmon and so are not exposed to lice.

Focus:
Value: 1.0 (0.8 for content, 0.2 for writing)
Feedback:

Good answers should contain:
2a. Fresh water kills sea lice on returning adults.
2b. Near-shore sea lice from last year’s adults are washed away by the tides and currents before juvenile salmon arrive.

Common errors:
2c. No points for describing the effects of salmon farms.

Reference: Fig. 1A, Alexandra Morton video.
Standard feedback on writing

Feedback on writing:
A. spelling errors and typos
B. capitalization errors
C. punctuation errors
D. grammar errors
E. word choice errors
F. sentence errors (not complete, run-on)
G. organization of ideas
H. answer not concise or not specific
I. irrelevant information
J. answer does not address question
K. no answer or no explanation
L. writing is sufficiently incoherent that specific errors cannot easily be identified.
M. unacceptable copying from other sources; failure to write in own words
N. answer is not in the form specified (e.g. a paragraph is at least three sentences).

Strategies and resources for improving your writing:
1. Read *A Short Guide to Writing about Biology*, especially pages 100-128.
2. Ask a friend with good English skills to read over your answers.
3. Read the information about plagiarism posted in the Resources folder.
4. Compose your answers in Word, with the spelling checker and grammar checker turned on. Word will underline in red every word it thinks is misspelled, and in
The data

How will we measure the effects of the homework types?

On learning of content:
- Scores on the open-book midterm (some written, some MC).
- Answers on ‘test’ and ‘control’ sets of MC questions on the open-book final exam.

On writing ability:
- Writing scores on reading-quiz questions
- Writing scores on written final-exam questions
- Writing scores on project reports (n=~50 in each group)

Effect of M-C homework and of reading-quiz questions?
- Scores on identical essay question in final exams of 2007 and M-C 2008 students

Other inputs:
- Survey of all students homework experience
- Focus groups
Things that have gone wrong

Edumetry initially offered to do the grading for free, but backed out after the first homework (after grading it so badly that we didn’t count the grades).

Returning the homeworks took nearly two weeks.

Most students usually didn’t read their homework feedback.

We couldn’t integrate our feedback comments into students’ answers.
Things that have gone well

Students didn’t mind being part of an experiment (we normalized the grades over the two groups).

We were able to use Vista (Blackboard) quizzes.

Vista creates and handles groups well.

Our grader was excellent.
The costs

**Time:** Lots
- Developing the homeworks
- Developing the keys
- Developing the exams
- Scoring the writing
- Analyzing the data
- Writing the paper

**Money:** Not so much
- ~$2500 for the grader
- ~$5000 for assistance with scoring
The Results and Conclusions