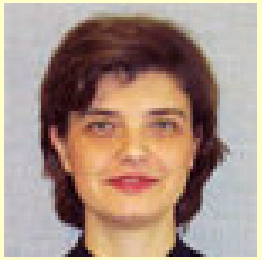
Life Sciences  Carl Wieman Science Education Initiative

Who are we?

Tamara Kelly, Ph.D.
STLF

Harald Yurk, Ph.D.
STLF

Jared Taylor, Ph.D.
STLF



Gülnur Birol, Ph.D.
Skylight Associate

Many faculty and students

Life Sciences Carl Wieman Science Education Initiative

What should students learn?

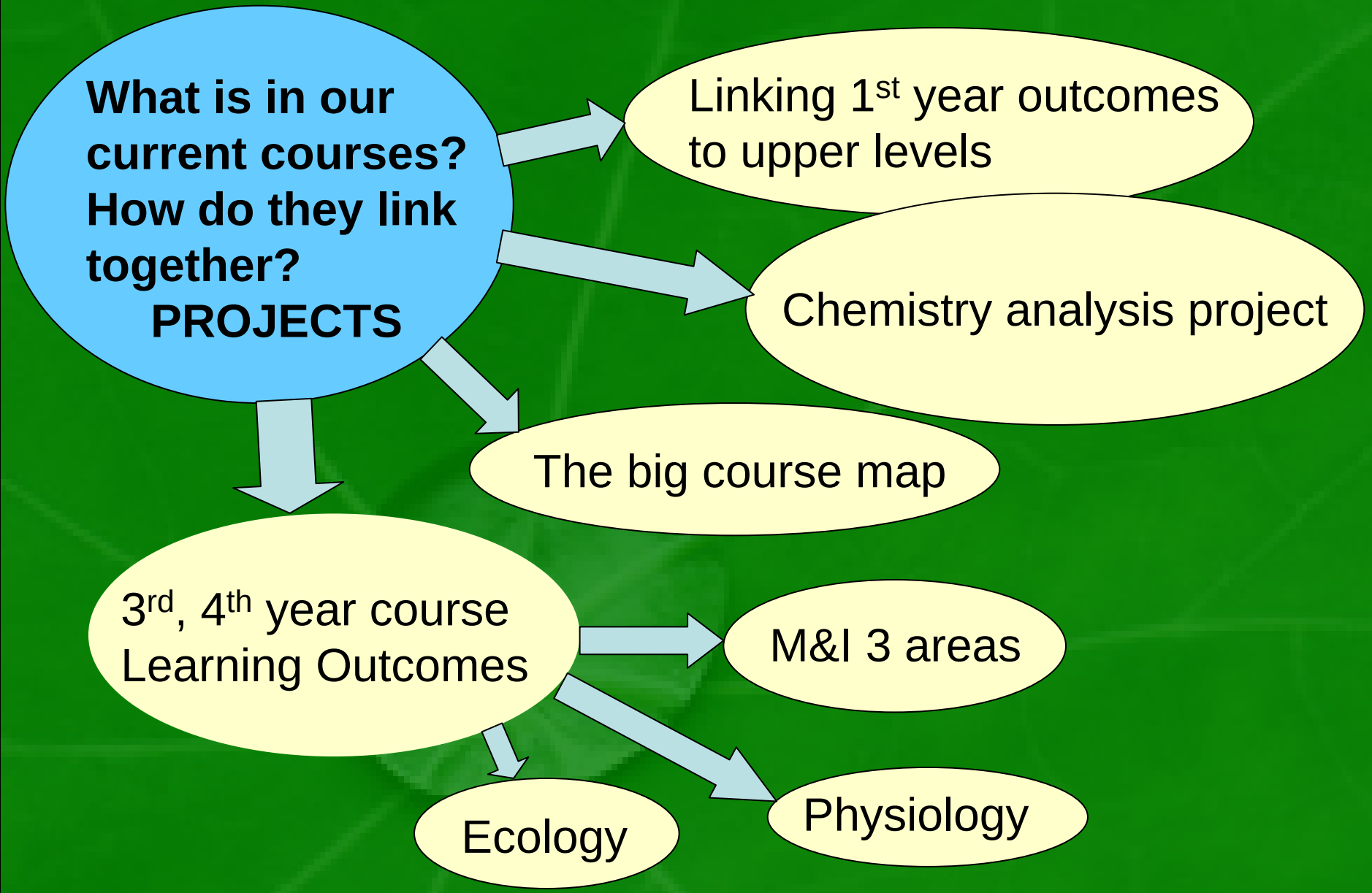
What are students learning now?

What improves student learning?

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

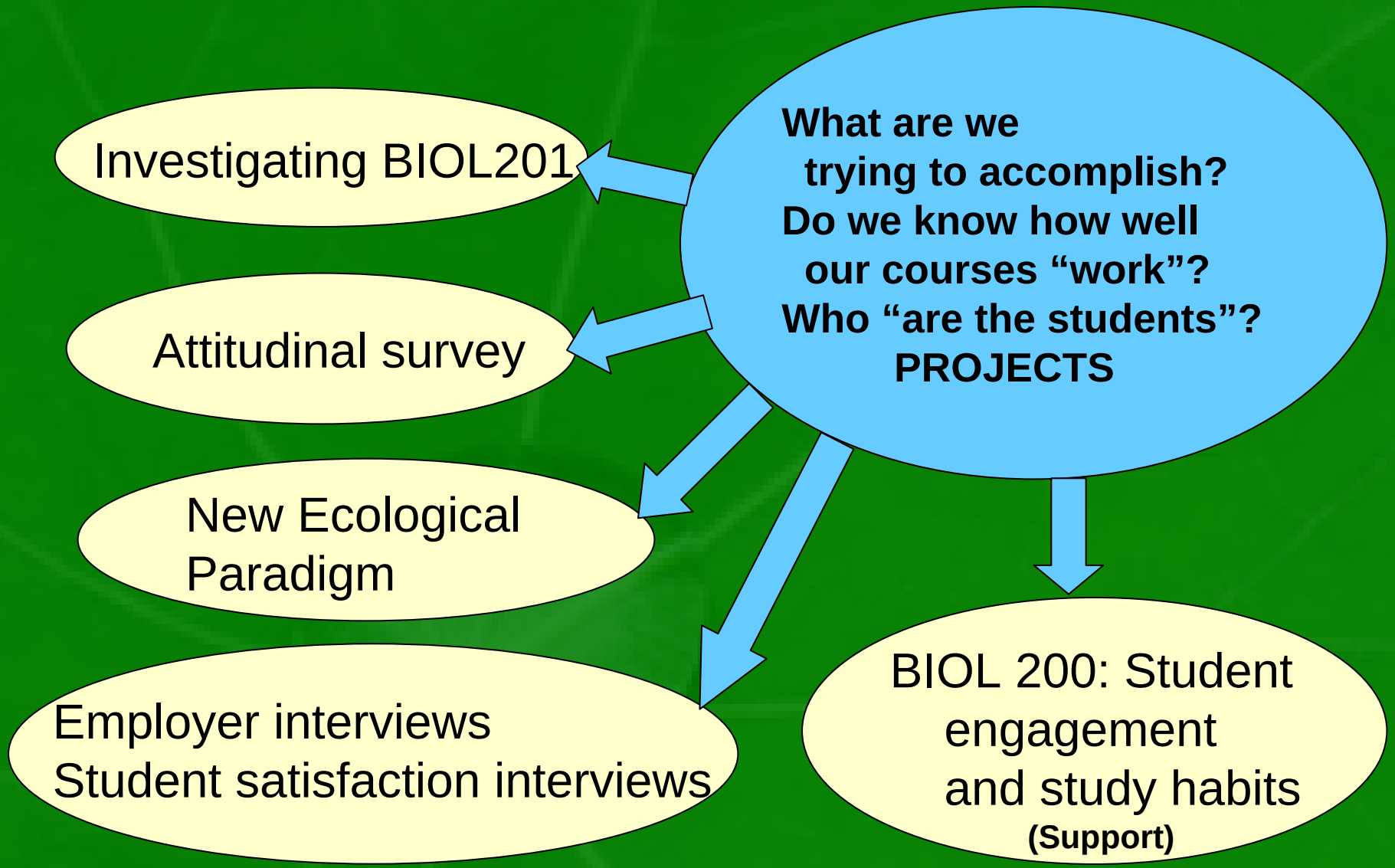

What is in our current courses? How do they link together?
PROJECTS
Linking 1st year outcomes to upper levels
Chemistry analysis project
The big course map
3rd, 4th year course Learning Outcomes
M&I 3 areas
Physiology
Ecology

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

**Chemistry analysis project**
***Lots of faculty***
***Jared Taylor***

**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 BIOL201
Attitudinal survey
New Ecological Paradigm
Employer interviews
Student satisfaction interviews
BIOL 200: Student engagement and study habits
(Support)

## Investigating BIOL201

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

**What are we trying to accomplish?**
**Do we know how well our courses "work"?**
**PROJECTS**

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

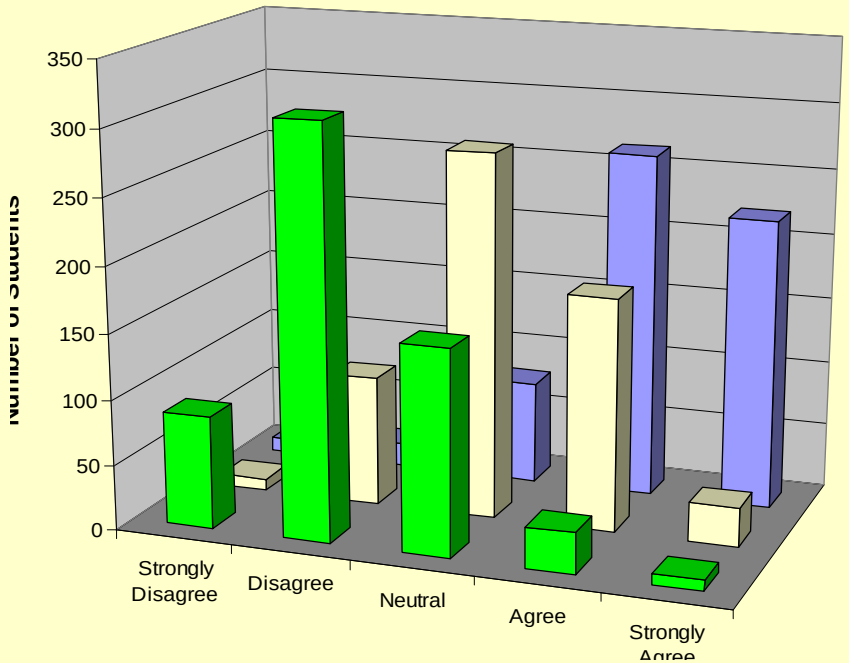
1. Chemistry Pre-test.
2. Student focus group interviews.
3. Follow-up Survey.
4. PRS question database (on-going).

# Investigating BIOL201

Follow-up Survey

What are we trying to accomplish?
Do we know how well [illegible]rk"?

## 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*

**Attitudinal survey**

**What are we trying to accomplish? Do we know how well our courses "work"? PROJECTS**

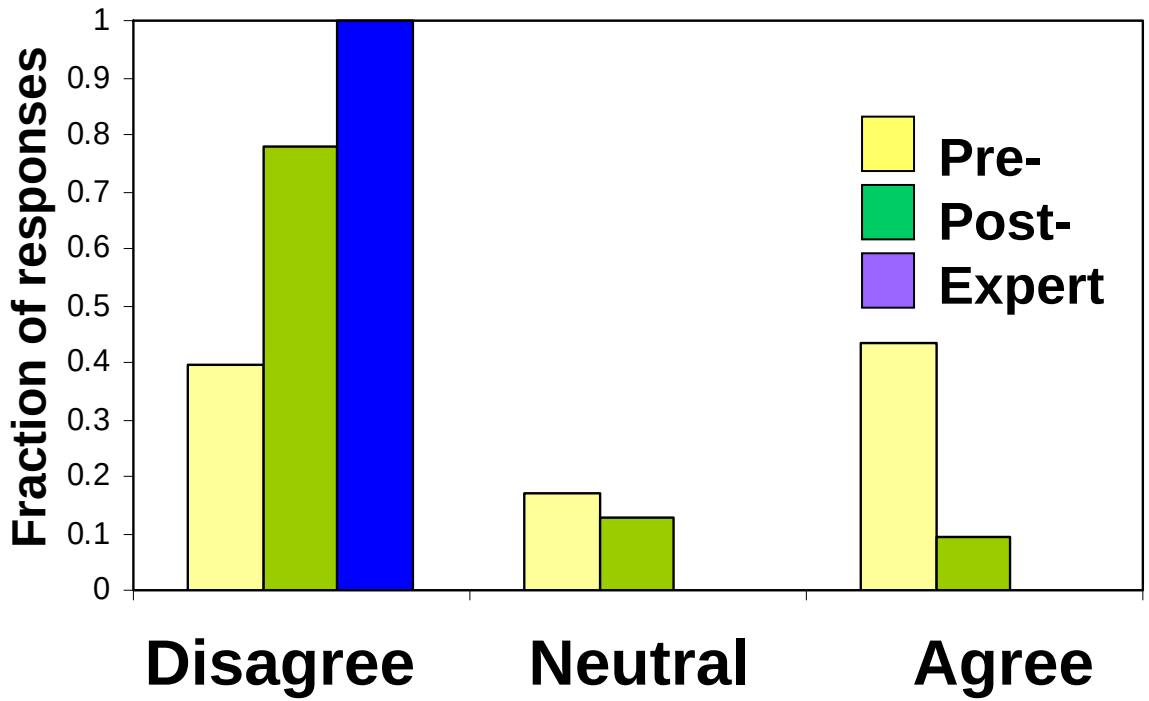
1. Piloted in BIOL111, BIOL112, BIOL121 term 1, 2007/08
2. Questions revised.
3. 2nd run BIOL112, BIOL121 BIOL201 term 2, 2007/08 (data available in June).
4. Collecting responses from experts.
5. Collaborating with CU Science Education Initiatives.

## Results from BIOL 111

## Attitudinal survey

**What are we trying to accomplish? Do we know how well our courses "work"? ECTS**

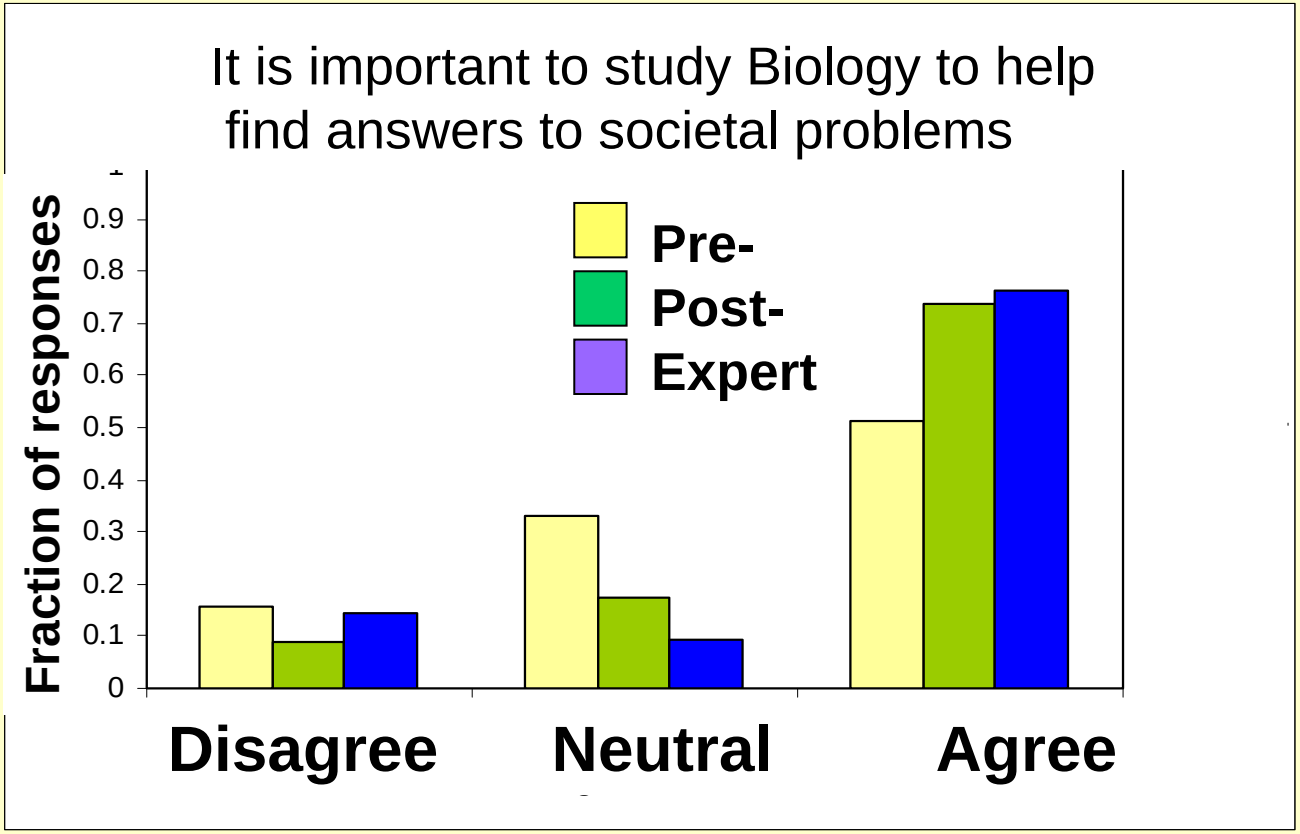
Learning Biology that is not directly relevant to or applicable to human health is not worth my time.



**Attitudinal survey**

**Results from BIOL 111**

**What are we trying to accomplish? Do we know how well our courses "work"? CTS**



New Ecological Paradigm
*Faculty teaching ecology*
*Harald Yurk*

**What are we trying to accomplish? Do we know how well our courses "work"? PROJECTS**

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

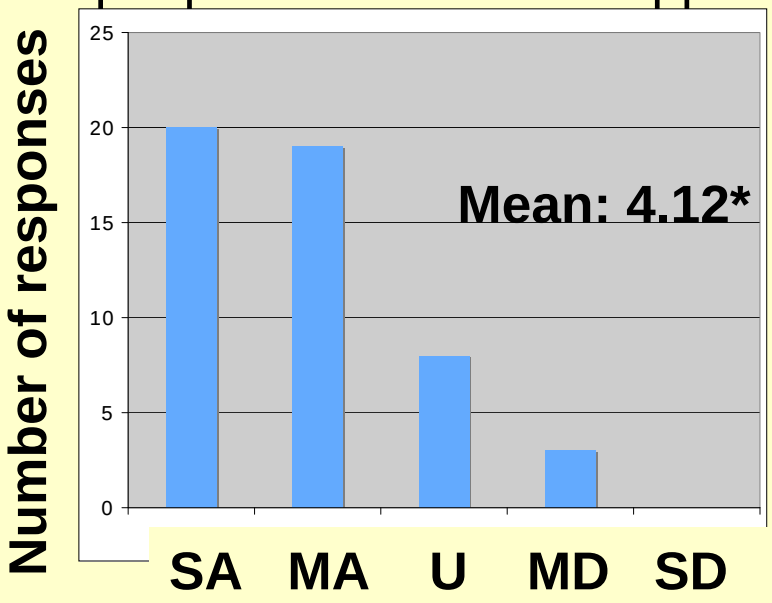
Journal of Social Issues, 56: 425-442 (2000).

# New Ecological Paradigm

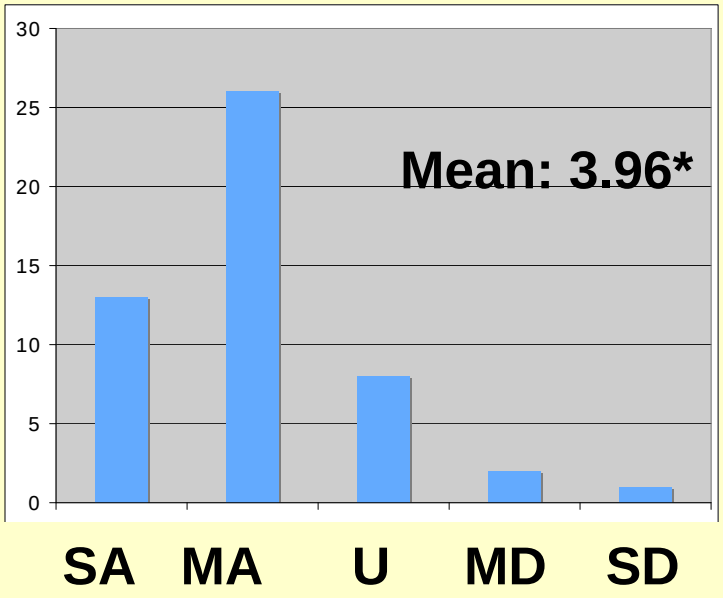
1st year students

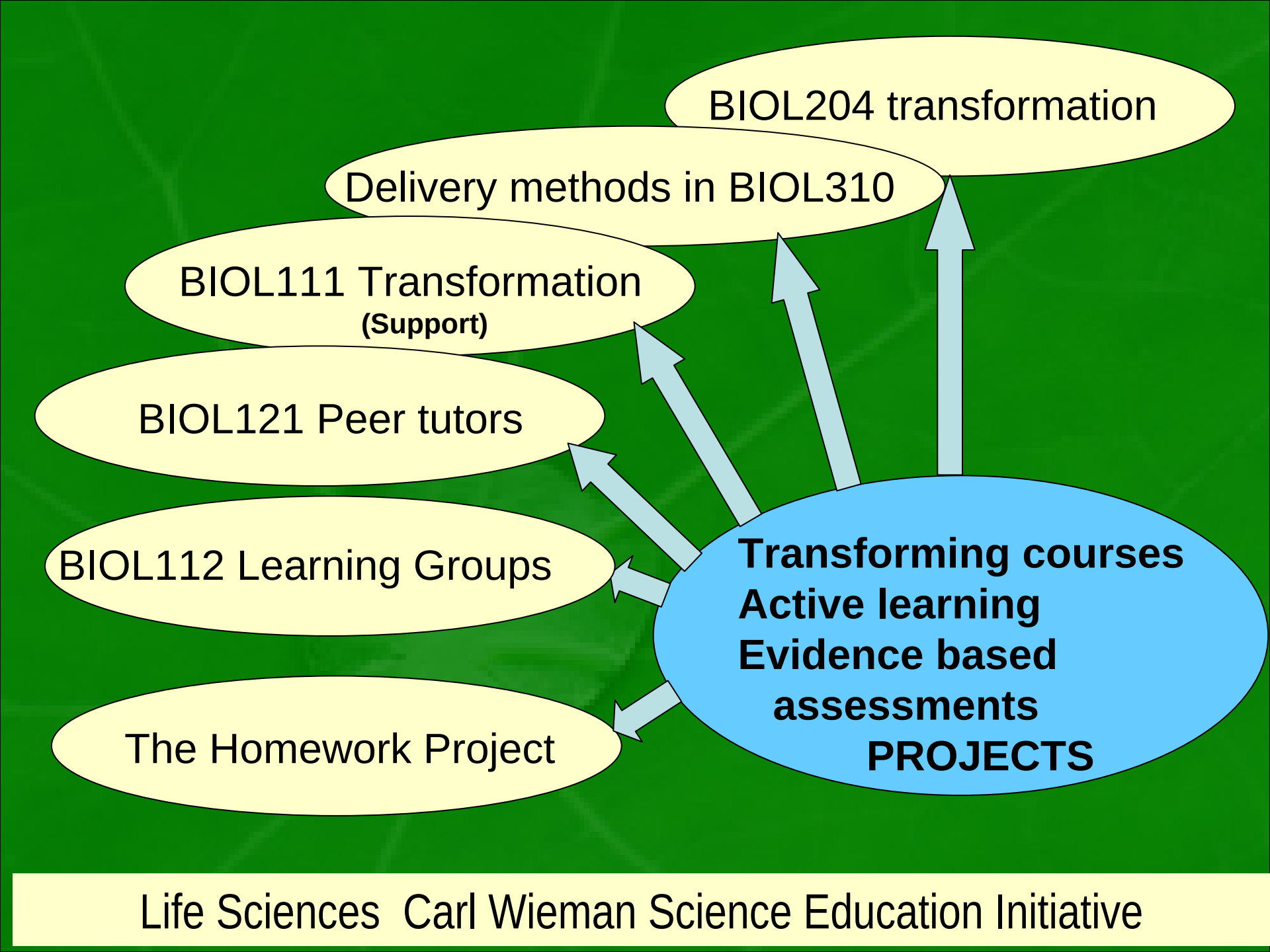
**What are we trying to accomplish? Do we know how well our courses "work"? PROJECTS**

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




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




BIOL204 transformation
Delivery methods in BIOL310
BIOL111 Transformation
(Support)
BIOL121 Peer tutors
BIOL112 Learning Groups
The Homework Project
Transforming courses
Active learning
Evidence based
assessments
PROJECTS

BIOL204 transformation

*Angie O'Neill*

*Bill Milsom*

*Faculty teaching physiology*

**Transforming courses**
**Active learning**
**Evidence based assessments**
**PROJECTS**

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.

**BIOL204 transformation**

**Transforming courses**
**Active learning**
**Evidence based assessments**
**PROJECTS**

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.

# Delivery methods in BIOL310

*Leticia Avilés Zoology*
*Jessica Purcell, Zoology*
*Harald Yurk*

**Transforming courses**
**Active learning**
**Evidence based assessments**
**PROJECTS**

3rd year course, 40 students
Topic is animal behaviour

**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**

**Transforming courses**
**Active learning**
**Evidence based assessments**
**PROJECTS**

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

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

## BIOL112 Learning Groups

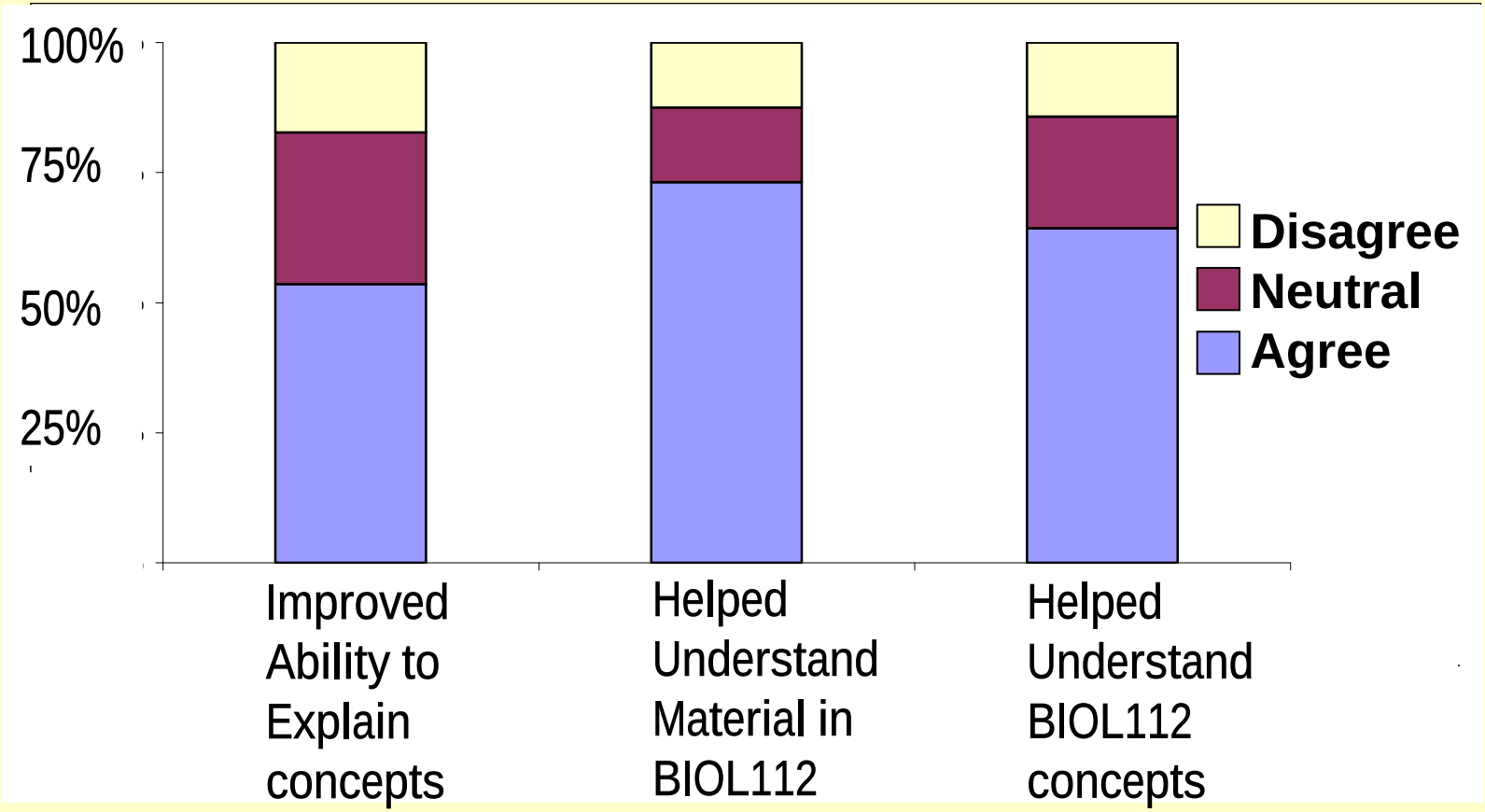
**Transforming courses**
**Active learning**
**Evidence based assessments**
**PROJECTS**

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

Transforming courses
ctive learning
Evidence based
assessments

Survey data



**Transforming courses**
**Active learning**
**Evidence based assessments**
**PROJECTS**

# 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

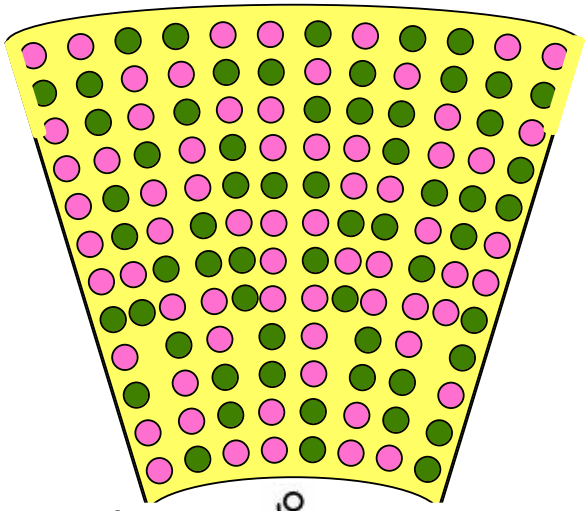
# The question(s)

Does written rather than multiple-choice homework

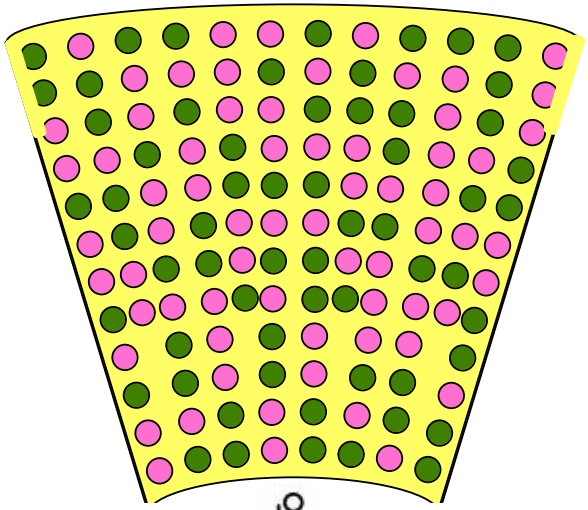
1. Improve students writing ability?
2. Improve students' understanding of concepts?

## Previous experiments?

- Poor controls
- Small sample sizes
- Qualitative, not quantitative



Section 223



Section 224

# The experiment

*Rosie Redfield*

*Tamara Kelly (STLF)*

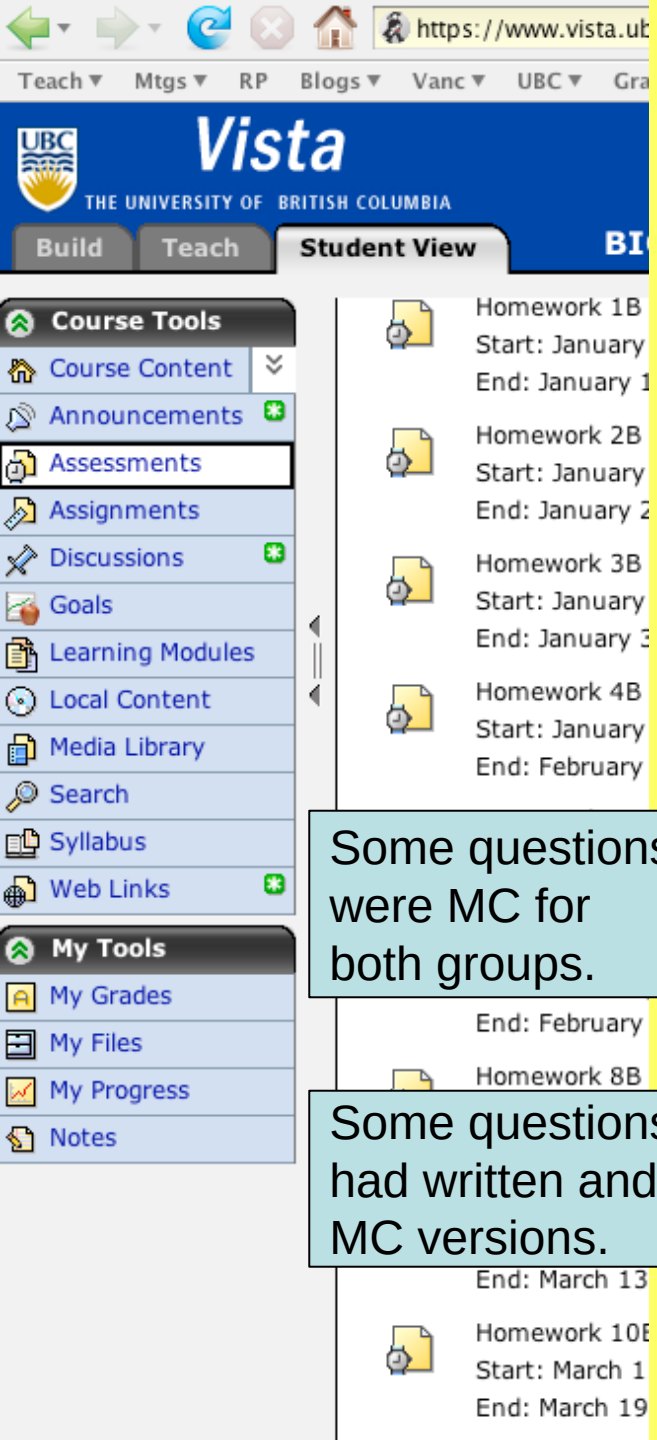
~ 400 BIOL 121 students randomized into two groups:

- 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 were MC for both groups.

Some questions had written and MC versions.

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

*You're encouraged to discuss the homework assignments with other stu*
*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
   which summarizes the pre-farming and post-farming relationship between wild Pacifi
   farmed salmon, and the sea louse *L. salmonis*.
2. Watch the video of fisheries biologist Alexandra Morton addressing the annual genera
   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 Mo

**Question 1.** Alexandra Morton does not explain to the Cermac AGM why she initially e
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
infestation of wild juvenile chum and coho salmon from sites close to farms and from ar

# 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.

# Example of feedback on content

**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

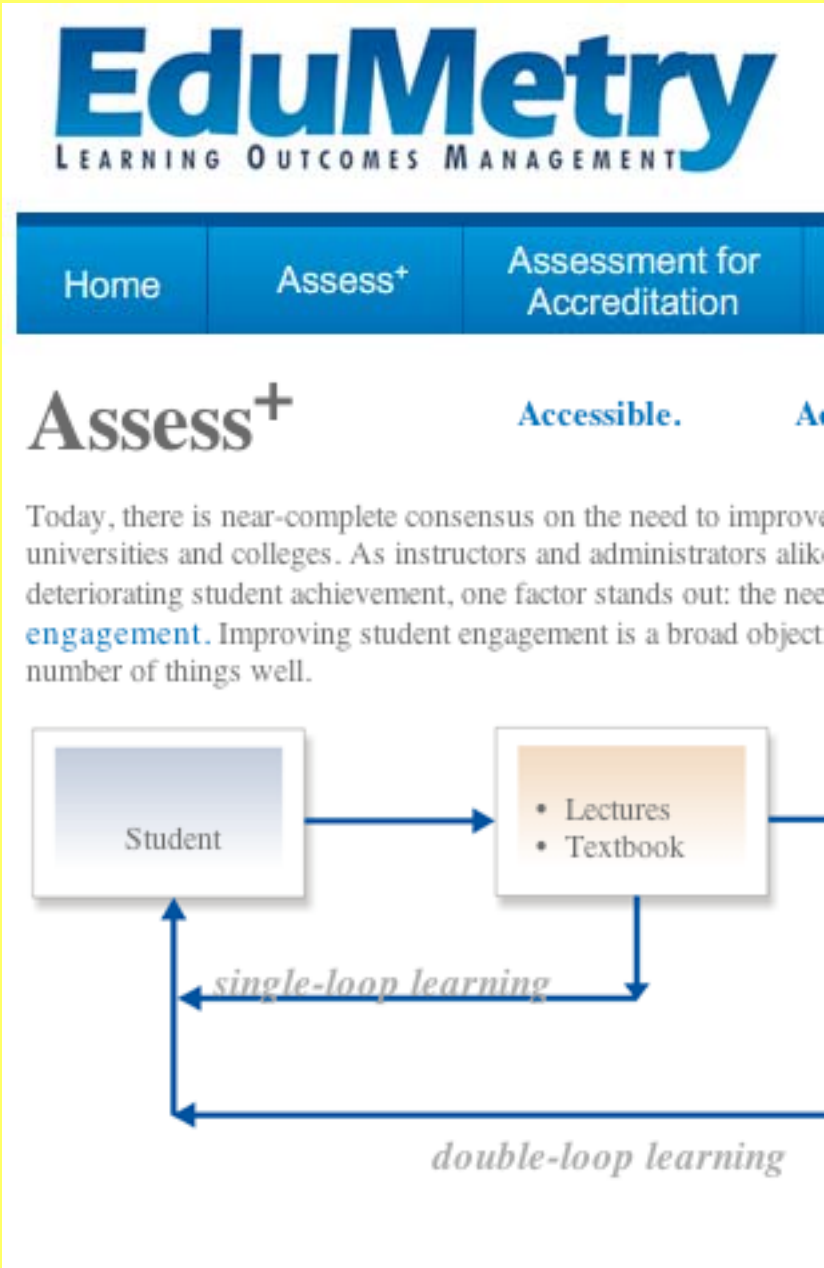
# Things that have gone wrong

Edumetry intially 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.



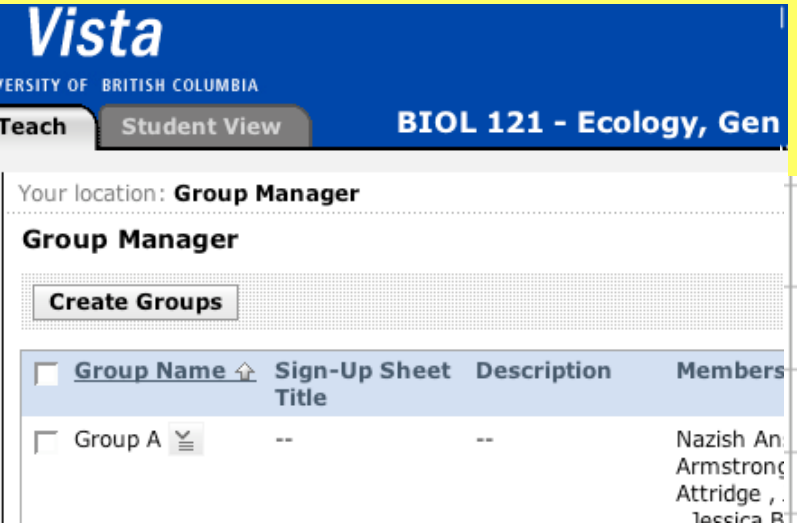
# Things that have gone well

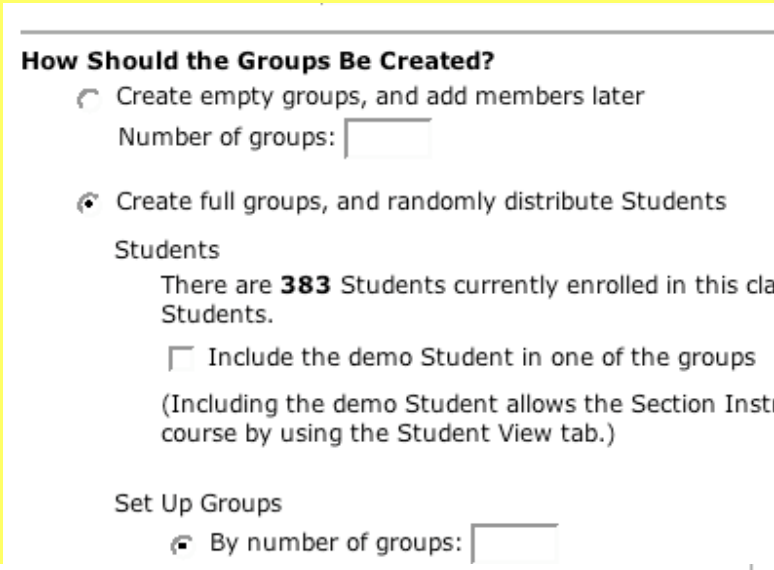
Students didn't mind being part of an experiment (we normalized the grades over the two groups).

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