



Carl Wieman Science Education Initiative  
at the University of British Columbia

2010-11 End of Year Event

Talks

**Overview of CWSEI progress** – Sarah Gilbert, CWSEI Acting Director

**Faculty Experiences:**

Georg Rieger (Physics)

Susan Allen (Oceanography)

Gary Bradfield (Ecology)

Mark MacLean (Mathematics)

**Poster session 11am-1:30pm room 261**

**Details on what's happening (& food)**

**1:30 – 2:50pm, room 182 – Example Class followed by discussion**

*lead by Harvey Richer*

**Workshops:**

**3:00 – 4:30pm, room 185 – Designing in-class activities**

**3:00 – 4:30pm, room 260 – Effective Peer Instruction using clickers**

# CWSEI “Trinity” for each course

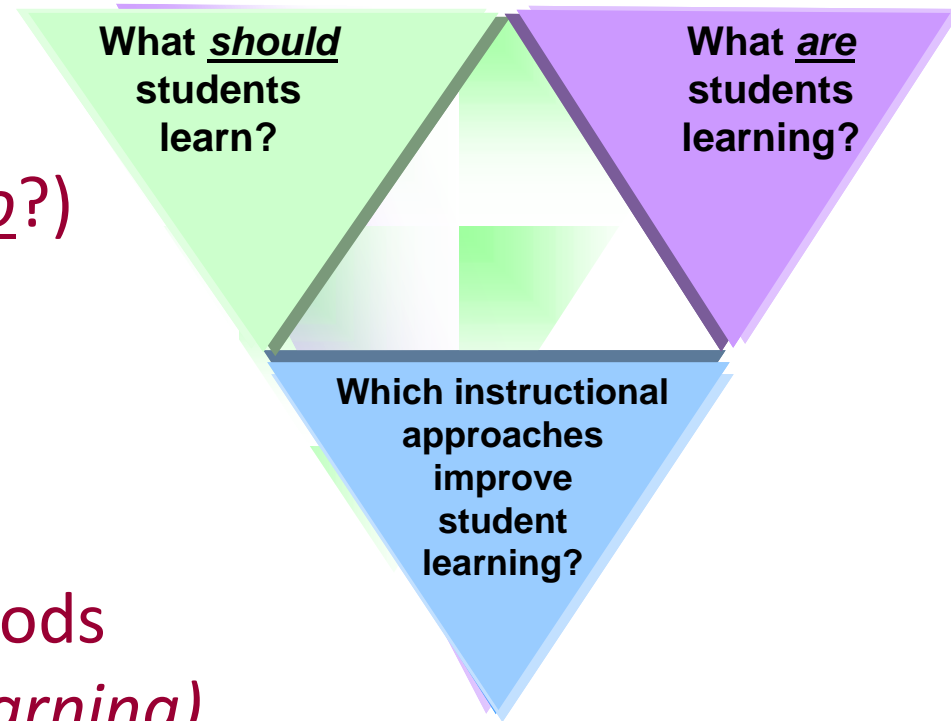
1<sup>st</sup>: Learning goals. (what should students be able to do?)

2<sup>nd</sup>: Good assessment  
(validated tests)

3<sup>rd</sup>: Improved teaching methods  
*(research based, improve learning)*

Materials, assessment tools, homework, notes ...  
saved, reused, improved.

Making teaching more effective, and more rewarding for  
faculty and students



## Carl Wieman Science Education Initiative

Started 4 years ago  $\Rightarrow$  goal is widespread improvement in science education at UBC, focusing on department level.

CWSEI Programs at various scales and stages:

Large scale & in later stage – **Earth & Ocean Sciences**

Large & Medium scale at earlier stages:

**Physics & Astronomy**

**Mathematics**

**Computer Science**

**Life Sciences**

Smaller scale programs – **Chemistry, Statistics**

\$2 M gift from David Cheriton for Math and Computer Sci.



## Overview of Progress (More details in talks & posters)

### Earth & Ocean Sciences

*STLFs: Francis Jones, Brett Gilley, Erin Lane, & Josh Caulkins; CWSEI  
Dept. Director: Sara Harris*

- About 60% of faculty have made significant changes to teaching.
- 20 courses undergoing or completed transformation plus another 10 improved with SEI help
- Typical new things:
  - clearly articulated learning goals for students & faculty
  - pre-reading assignments & quizzes
  - clicker questions and peer discussion
  - worksheets & in-class group activities
  - 2-stage exams (individual + group)
  - team projects
  - pre-post testing to measure learning, ...

*much more active learning and feedback*

COURSE	LEARNING GOALS	NEW ASSESSMENTS	IMPROVED METHODS
<p>EOSC 211: Computer Methods in Earth, Ocean &amp; Atmosph. Sciences (Jan '09 start)</p> <p><u>Faculty:</u> R. Pawlowicz, C. Johnson <u>STLF:</u> Josh Caulkins</p> <p> <u>Poster: Investigation of student perspectives: focus group set up &amp; findings from EOSC 211</u></p> <p> <u>Poster: Transformations and results</u></p>	<p>Course-level goals: complete</p> <p>Lecture-level goals: complete</p> <p>Learning goals for Labs/Assignments: draft</p>	<p>Pre-post assessment: Administered in Teach 1 and edited for Teach 2, can be used "as is" for all future terms</p> <p>Midterm and end-of-term surveys</p> <p>New types of exam questions based on computer science concepts</p>	<p>In-class worksheets for every lecture</p> <p>Pair-programming used in all labs and assignments.</p> <p>Name-sticks used to call on students during lectures and in-class discussions</p> <p>Post-lecture Interviews</p> <p>Lab interviews</p>
<p>EOSC 212: Topics in the Earth &amp; Planetary Sciences (Jan '08 start)</p> <p><u>Faculty:</u> M. Jellinek, M. Bostock <u>STLF:</u> Francis Jones</p> <p>Final transformation term was Fall'09, but further refinements of generic science thinking activities and assessments were</p>	<p>Course-level goals: complete</p> <p>Focus is on science thinking skills rather than content</p>	<p>End-of-term survey for project evaluation</p> <p>Quizzes on readings for both individual and teams, using Team Based Learning strategies</p> <p>Two projects (presentation and poster), including feedback at multiple stages of delivery</p> <p>Pre-post test related to model-based reasoning</p>	<p>Vista Course Management System used extensively for content delivery, quizzing, surveying, logistics.</p> <p>Team Based Learning elements: permanent teams, individual/team quiz protocols &amp; in-class team activities</p> <p>Content from Scientific American and other articles and lectures</p> <p>Three modules chosen to highlight Departmental research strengths</p>



<p><b>EOSC 372:</b> Introductory Oceanography: Circulation and Plankton (Jan '09 start)</p> <p><u>Faculty:</u> S. Allen, K. Orians, M. Maldonado, E. Lane <u>STLF:</u> Erin Lane</p>	<p>Course-level goals: complete</p> <p>Lecture-level goals: complete</p> <p>Assignment learning goals: complete</p>	<p>Mid-term survey</p> <p>End-of-term survey</p> <p>Daily online quizzes</p> <p>Pre-requisite knowledge diagnostic quiz</p> <p>Draft post test</p> <p>Student workloads questions</p>	<p>Widespread use of thought-provoking clicker questions</p> <p>Daily assignments with online quizzes</p> <p>In class demonstrations and analogies developed</p>
<p><b>EOSC 373:</b> Introductory Oceanography: Climate and Ecosystems (Sept '09 start)</p> <p><u>Faculty:</u> M. Maldonado, S. Allen, R. Francois, E. Lane <u>STLF:</u> Erin Lane</p>	<p>Course-level goals: complete</p> <p>Lecture-level goals: complete</p>	<p>Mid-term survey</p> <p>Draft diagnostic test</p> <p>Daily online quizzes</p>	<p>Widespread use of thought-provoking clicker questions</p> <p>Daily assignments with online quizzes</p>
<p><b>EOSC 472:</b> Introduction to Marine Chemistry and Geochemistry (Sep '09 start)</p> <p><u>Faculty:</u> K. Orians <u>STLF:</u> Joshua Caulkins</p>	<p>Course-level goals: complete, editing for new content</p> <p>Lecture-level goals: draft, editing for new content</p>	<p>Midterm and end-of-term surveys</p> <p>Reading quizzes introduced</p> <p>Reworked homework sets</p> <p>Term papers enhanced to be a "critical review paper" which includes greater depth of comprehension</p>	<p>Weekly worksheet activities</p> <p>Anonymous peer-reviewed writing assignment with instructor feedback</p> <p>Post-lecture student interviews</p> <p>Investigating new textbook options, perhaps introducing a packet of articles</p> <p>name sticks used during lectures</p>

Susan Allen talk about her experience transforming Oceanography courses

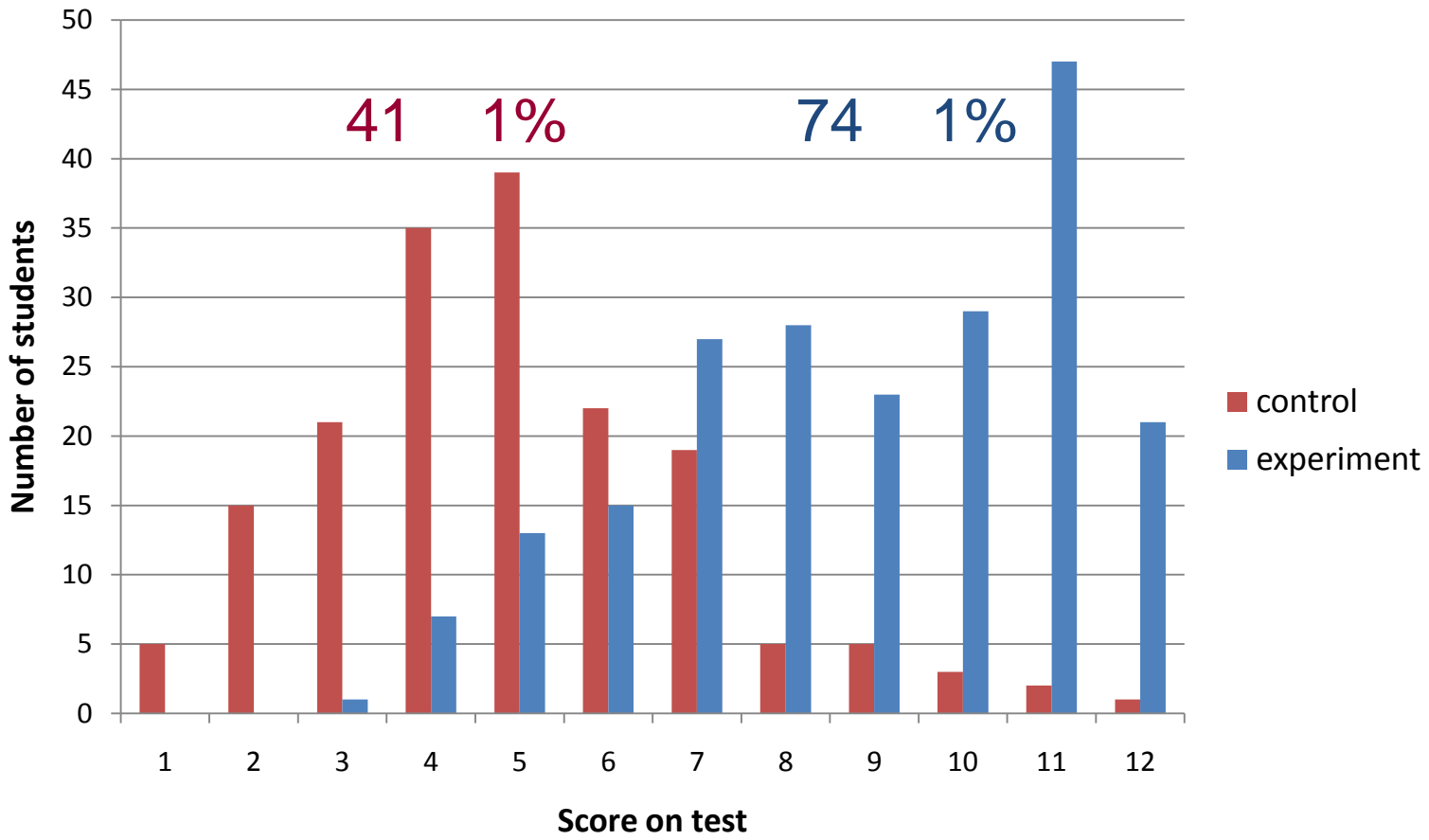
# Physics & Astronomy



*STLFs: Louis Deslauriers, James Day, Jim Carolan, Cynthia Heiner, Peter Newbury, & Ido Roll; CWSEI Dept. Director: Mona Berciu*

- Astronomy courses – *Exploring the Universe I & II*  
*Harvey Richer example class at 1:30pm in this room*
- Intro Physics courses: *Phys 100, 101, 102, 107, 109, 153*  
*Georg Rieger talk about his experience transforming courses*
- Higher level Physics courses: *Phys 200, 250, 304, 408, 450*
- Some courses have no lectures anymore  
*Workshop on designing activities this afternoon at 3:00pm;*  
*David Jones will be sharing his experience transforming Phys 408*

# Mini-transformation in Physics 153 (Electromagnetic Waves topic)



**Status: Accepted for publication in Science**

Results inspired department to do full transformation of course  
*Mini-transformations in Phys 102 in Spring 2011*



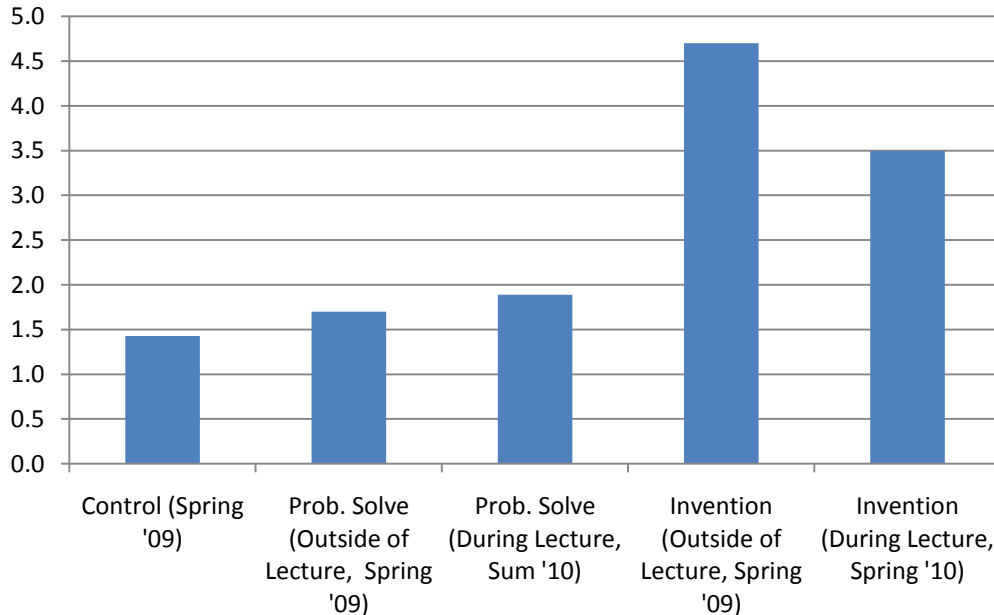
# Life Sciences

*STLFs: Jared Taylor & Malin Hansen;  
CWSEI Dept. Director: George Spiegelman*

- **BIOL 112 – Cell Biology**

*Invention activities, investigation activities, In-class writing assignments, clicker questions & peer discussion, ...*

Coming up with plausible mechanisms for biological process student never encountered before:



Published in CBE-Life Sciences Education

**Selected for inclusion in the 2010 Highlights issue**

- **Ecology courses BIOL 304 & 306**

Fundamentals of Ecology and Advanced Ecology redesigned around the questions:

- Why do species differ in their population dynamics?
- How do species coexist?
- Are communities stable?
- Are humans reducing the ecosystem services on which we depend?

*Gary Bradfield talk about his experience transforming Biol 306 - Advanced Ecology*

# Mathematics

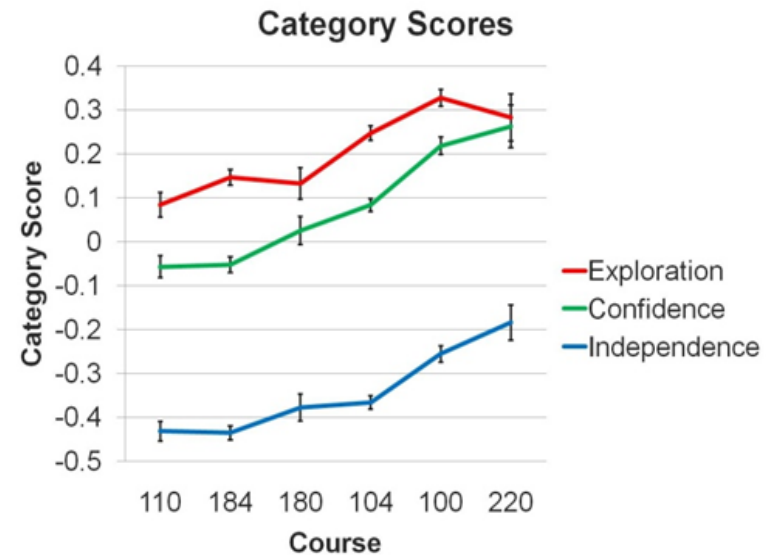
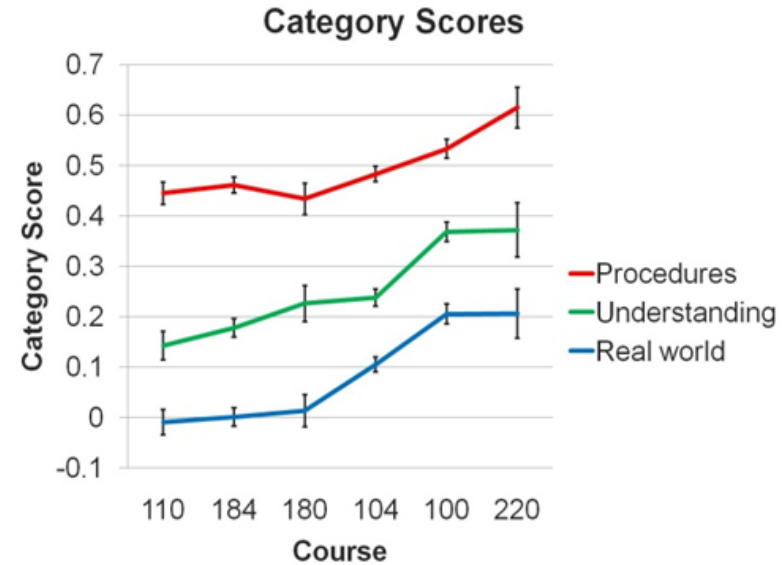
*STLFs: Warren Code, Joseph Lo, & Sandi Merchant; CWSEI Dept.  
Director: Costanza Piccolo*

- Calculus courses – *MATH 110, 104/184, 180/184 workshops*  
Major effort in *MATH 104/184 (Differential Calculus with Applications to Commerce and Social Sciences)*  
Mark MacLean will talk about what they did and how it went
- Computing/computer lab components – *Math 152, 256 (Mech 221), 257/316, 253 (Mech 222), & Math 307*
- Mathematical Proof – *Math 220*  
Developed pre-post test for basic proof skills, conducting student interviews, discovering interesting student thinking about proofs
- Mathematical Models in Science – *MATH 360 (new course)*
- Mathematics Attitudes Perceptions Survey *under development*

*6 posters on above projects*

# MAPS: Mathematics Attitudes Perceptions Survey

- Dependence on procedures  
*e.g. To learn math, I only need to memorize solutions to sample problems.*
- Need to understand formulas or procedures  
*e.g. In math, it is important for me to make sense out of formulas and procedures before I can use them correctly.*
- Relation to real world  
*e.g. Learning math changes my ideas about how the world works.*
- Exploration in problems solving  
*e.g. There are times I solve a math problem more than one way to help my understanding.*
- Confidence  
*e.g. If I get stuck on a math problem, there is no chance that I will figure it out on my own.*
- Independence in learning  
*e.g. I cannot learn math if the teacher does not explain things well in class.*



# Computer Science

*STLFs: Ryan Golbeck & Allison Tew; CWSEI Dept. Director: Paul Carter*

- Software Practices Stream – CPSC 110, 210, 310, 410

## **Helping with new CPSC 110 & 210**

### **Longitudinal study**

measure how student knowledge develops and how well that knowledge is retained across a series of courses in their curriculum (measuring the progress towards expertise)

- Interviewed faculty
  - Analyzed course learning goals
  - Working to develop and pilot the instruments
- A number of smaller & ongoing projects  
*See posters by Kim Voll & Andre Malan and Elizabeth Patitsas & Steve Wolfman for a sample*



# Chemistry

Large first year labs – *CHEM 121 & 123*

*Jennifer Duis, Sophia Nussbaum, Laurel Schafer, Jackie Stewart*

- Develop laboratory learning goals
- **Developed & validated 9 instruments to measure laboratory learning**
  - Uncovered areas of difficulty and misconceptions
  - Data to direct targeted enhancements
- Increased knowledge of incoming student background
- Data supporting student appreciation of learning goals
- Improved student attitude/perception agreement with experts
- Insight into employer, faculty and student impressions of UBC laboratory skills
- **Undergraduate Research Assistants – significant involvement**
  - Student researchers learned to:
    - 1) Design and/or revise/validate educational research tools (eg. surveys)
    - 2) Collect and manage large data sets (n = 1000)
    - 3) Code and statistically evaluate data using various statistical methods
    - 4) Interpret and present their results in written and oral formats
  - \*\* see posters\*\*



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**Lots of great progress - talks & posters give more details**

Talks

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