Carl Wieman Science Education Initiative
at the University of British Columbia

2013-14 End-of-Year Event

9:30-noon – Morning Session

- **Sarah Gilbert:** *Overview*
- **Simon Peacock:** *Teaching and learning initiatives in the Faculty of Science: Looking ahead*
- **Carl Wieman:**
  Designing homework to build expertise
  Two-stage review (with Jane Maxwell)
- **Trish Schulte:** *Revealing and addressing student misconceptions - reflections from the Biology classroom*

Noon-2pm: Light lunch & Poster Session

(ESB Atrium, 1st floor)

2-4pm - Workshop Sessions

Carl Wieman Science Education Initiative

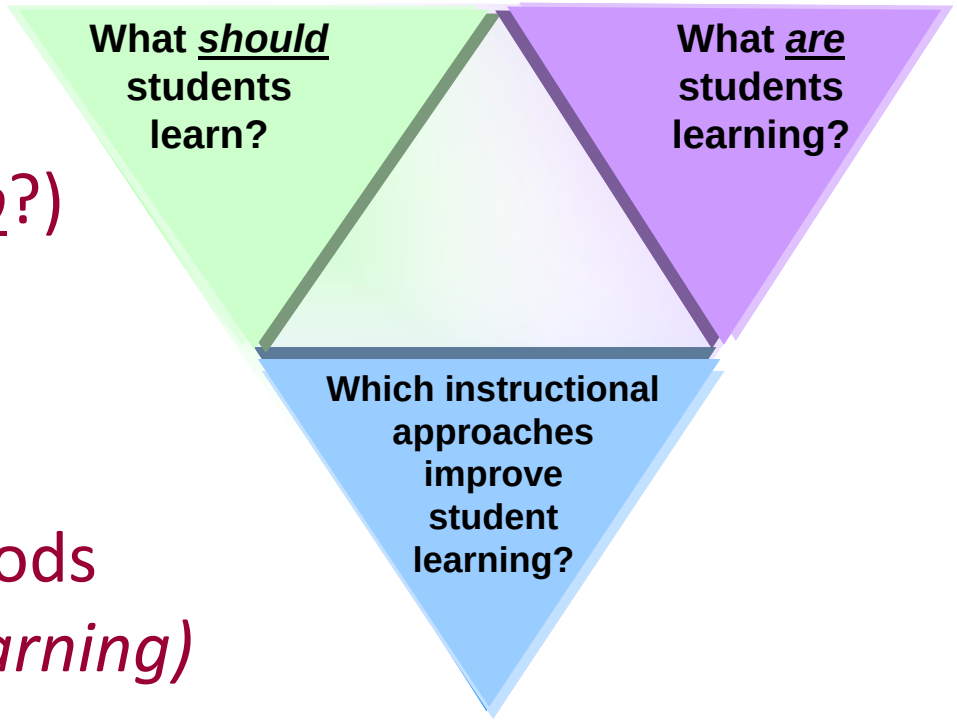
Started 7 years ago ⇒ goal is widespread improvement in science education at UBC, focusing on department level.

CWSEI "Trinity" for each course

1st: Learning goals. (what should students be able to *do*?)

2nd: Good assessment

3rd: Improved teaching methods
(research based, improve learning)



Typical new aspects incorporated in courses:

- **Clearly articulated learning goals (not just a list of topics)**
  - What the students should be able to *do*
- **Pre-class assignments (reading, screencast, …) & quizzes**
- **Efforts to increase student interest & motivation to learn subject (context, relevance, why useful/interesting, …)**
- **Interactive engagement targeted at learning goals**
  - Clicker questions and peer discussion – especially in large classes (challenging questions involving scientific reasoning best)
  - In-class group activities – with or without worksheets; effective even in large (250 student) classes
- **Homework problems targeted at learning goals**
- **Measures of learning repeated in different terms, surveys to gauge perceptions about science ...**

CWSEI Programs at various stages:

Ongoing:

- **Chemistry**
- **Computer Science**
- **Life Sciences**
- **Mathematics**
- **Statistics**

Later stage/wrapping up:

- **Physics & Astronomy**
- **Earth, Ocean & Atmospheric Sciences**

Chemistry

Science Teaching & Learning Fellows (STLFs): Kerry Knox & Jane Maxwell; CWSEI Dept. Director: Jackie Stewart

Two STLFs working on 4 courses; started about 1 year ago

Supporting instructional activities including: case-based learning, clickers, two-stage exams, in-class activities, a group poster assignment

CHEM 211/311: Analytical Chemistry
developing concept test, plan to track learning, 2-stage review in 311

CHEM 315/325/335/345: 3rd year integrated laboratories
mapping skills/knowledge & cognitive tasks in 3rd-year labs; helping evaluate new laboratory activities

CHEM 341: Global Challenges, a Chemistry Perspective
Combined majors in science program

4 posters

CHEM 341 - Global Challenges, a Chemistry Perspective

STLF: Kerry Knox (see poster)

From midterm survey; List the one or two aspects of this course that are most helpful for your learning:

"Being able to read articles relating to the topic and discussing them in class helps my learning the most. This helps me retain information the best and also helps improve my critical thinking skills."

"I find I retain the most information from interactive activities, such as those when we are given readings or told in advance to think about a particular topic, given group time to discuss or work on a worksheet, and then Prof. reviews the important concepts in a lecture-style format. Whenever there are worksheets my learning seems to be the most noticeable."

"Collaborating on group assignments forced me try harder in an attempt to preserve my ego.“

Computer Science

STLFs (part time): Donald Acton, Ed Knorr, Steve Wolfman
CWSEI Dept. Director: Ian Mitchell

Instructors as part-time STLFs

Currently working in 3 areas:

- Database stream (CPSC 304, 404) – Ed Knorr
- Systems stream (CPSC 213, 261, 313, 317, 415) – Don Acton
- Foundations of Computing stream (CPSC 121, 221, 320) – Steve Wolfman developing concept inventory for stream

Plus several other courses, such as:

- CPSC 344 – Human Computer Interaction (Jessica Dawson) pre-reading with quizzes, additional in-class interactive activities, scaffolded course project, pre- and post- surveys.
- Advanced numerical methods stream – CPSC 402, 406 (Michael Friedlander) – Case studies replace 1/3 of lectures and half of assignments.

3 posters

Computer Science

Department-level activities:

- Second department teaching workshop scheduled for early May. Members of the department give 10min talks about teaching interventions.

- Mechanical TA peer review software (home grown) used in four courses (CPSC 101, 110, 301, 430). Allows students who are reviewing well to move into an "unsupervised pool" in which they provide completely independent peer reviews, subject only to spot-checks and appeals.

Life Sciences

STLFs: Malin Hansen, Lisa McDonnell, Laura Weir, Megan Barker (& FLI), & Martha Mullally (& FLI); CWSEI Dept. Director: Trish Schulte

5 STLFs/Flexible Learning Initiative (FLI) fellows

2nd & 3rd year fundamentals courses in the newly-defined Biology curriculum and cross-linkages

Ecology, Genetics, Physiology, Evolution

New Flexible Learning Initiative effort in the 2 large 1st year courses (BIOL 112 & 121 Megan & Martha CWSEI/FLI)

4 posters

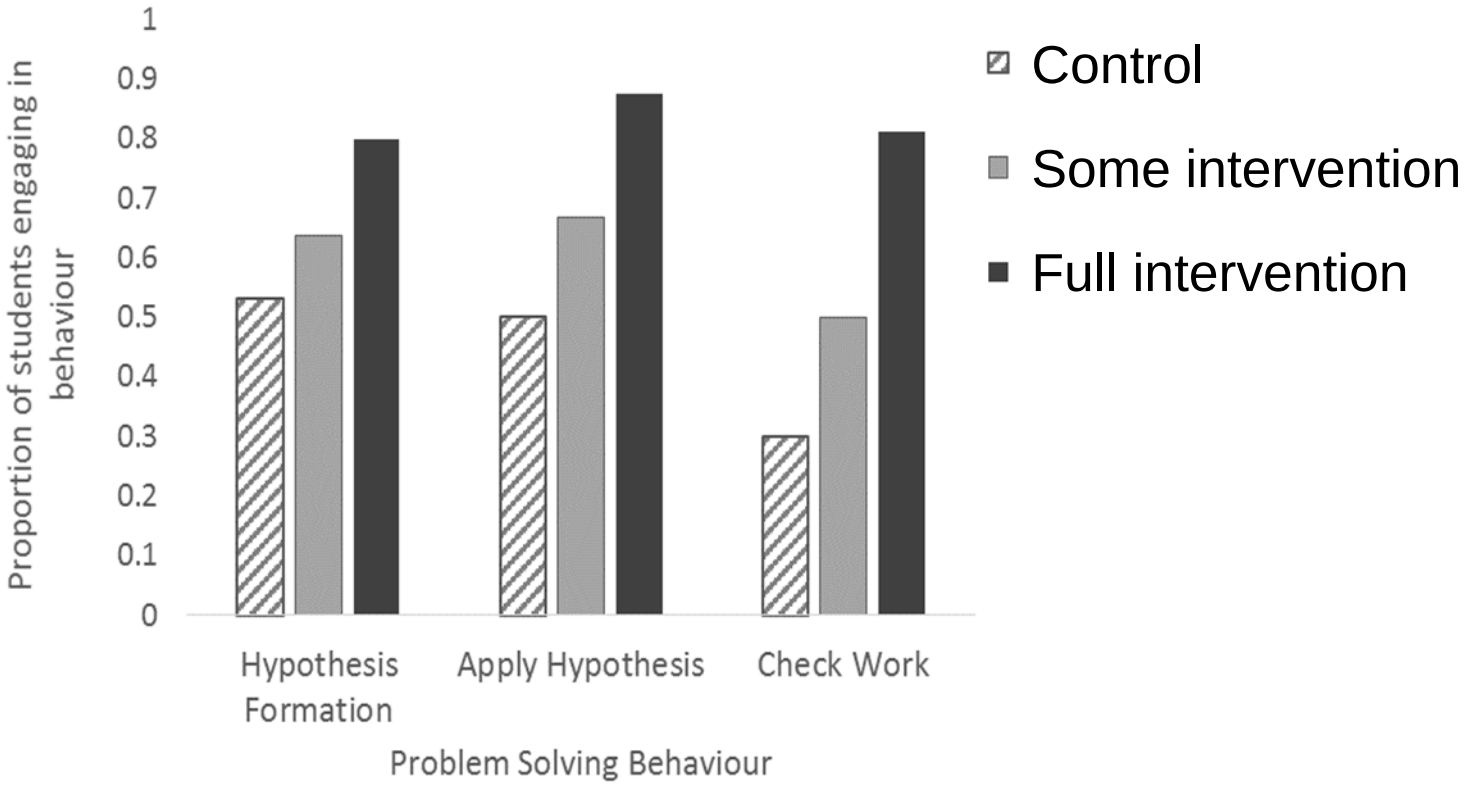
- Big classes, big teaching teams, big challenges
- Content first, jargon second study
- Influence of peer discussion on quality of student written explanations
- Improving student problem solving in genetics

Genetics Problem Solving Study

Lisa McDonnell

Developing expert problem solving skills

2nd year Genetics course – found that students rarely check their work, and lack of checking work was associated with not being successful at solving the problem. When students are explicitly taught, assessed, and given feedback on this skill, they subsequently spontaneously used it:



Mathematics

STLFs: Wes Maciejewski; CWSEI Dept. Director: Sandi Merchant (on leave), Costanza Piccolo (on leave)

- Piazza use – *new project*
  Studying how this discussion board is being used and perceptions
- Students' Approaches to Study – *new project*
  Surveying students in 1st, 2nd, & 3rd year math courses
- Tracking Proof Skills – *Math 220 & beyond*
  Developing a proof concept test to track proof skills retention & development in upper level courses – currently testing a mix of multiple-choice and long answer problems
- Incorporating online homework in many courses
  WeBWorK online homework now used in nearly all large 1st & 2nd year courses; affects ~5000 students per term. Conducted extensive surveying of students to assess how they use the online homework and provided advice to instructors on best use in their courses.

2 posters

Statistics

STLF: Gaitri Yapa; CWSEI Dept. Director: Bruce Dunham

- Extensive work on 6 courses
  - STAT 200: Elementary Statistics for Applications
  - STAT 241/251: Introductory Probability and Statistics
  - STAT 300: Intermediate Statistics for Applications
  - STAT 302: Introduction to Probability
  - STAT 305: Introduction to Statistical Inference
  - STAT 443: Time Series and Forecasting
- Introducing in-class activities and clicker questions; incorporating context-rich problems, adding homework assignments, improving labs, surveying TAs
- More than **85%** of faculty in dept. have now taught using interactive engagement

1 poster

Physics & Astronomy

Georg Rieger, Joss Ives, Jim Carolan, Ido Roll

CWSEI program in transition phase

- ~15 courses transformed + others impacted
- Completed major project on Physics 100 labs
  with grad students Mike Sitwell, Sophie Berkman, and Jared Stang

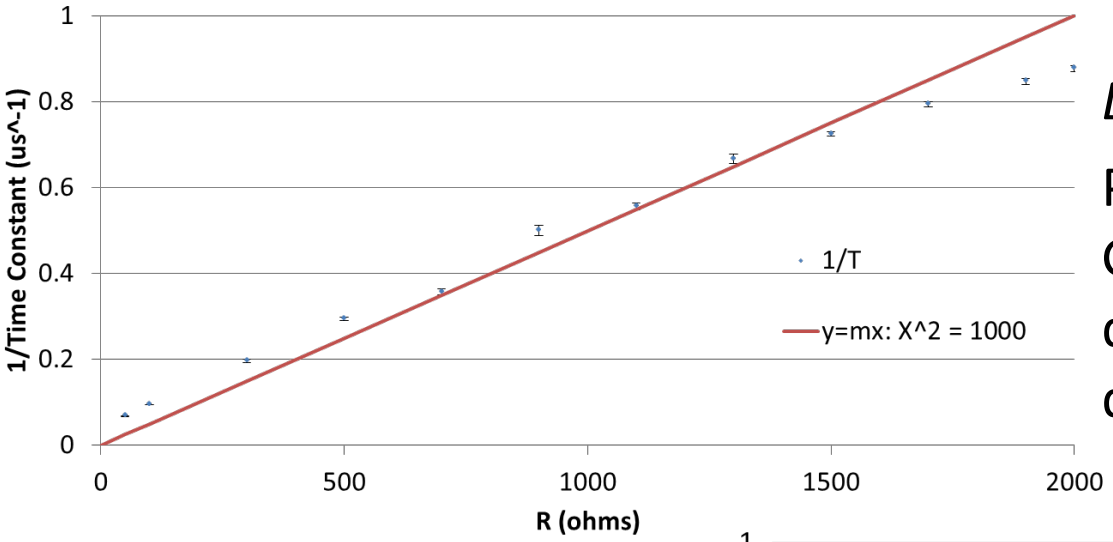
  Inquiry-based labs connected by lab homework; focus on understanding data analysis & planning of experiments to answer research questions (sometimes perform experiments at home).

  Final lab project to answer a research question with an experiment.
- Excellent TA professional development program run by TAs
- Exciting results in Physics 107/109 labs
  Critical thinking!

6 posters

Physics & Astronomy

Natasha Holmes & Doug Bonn

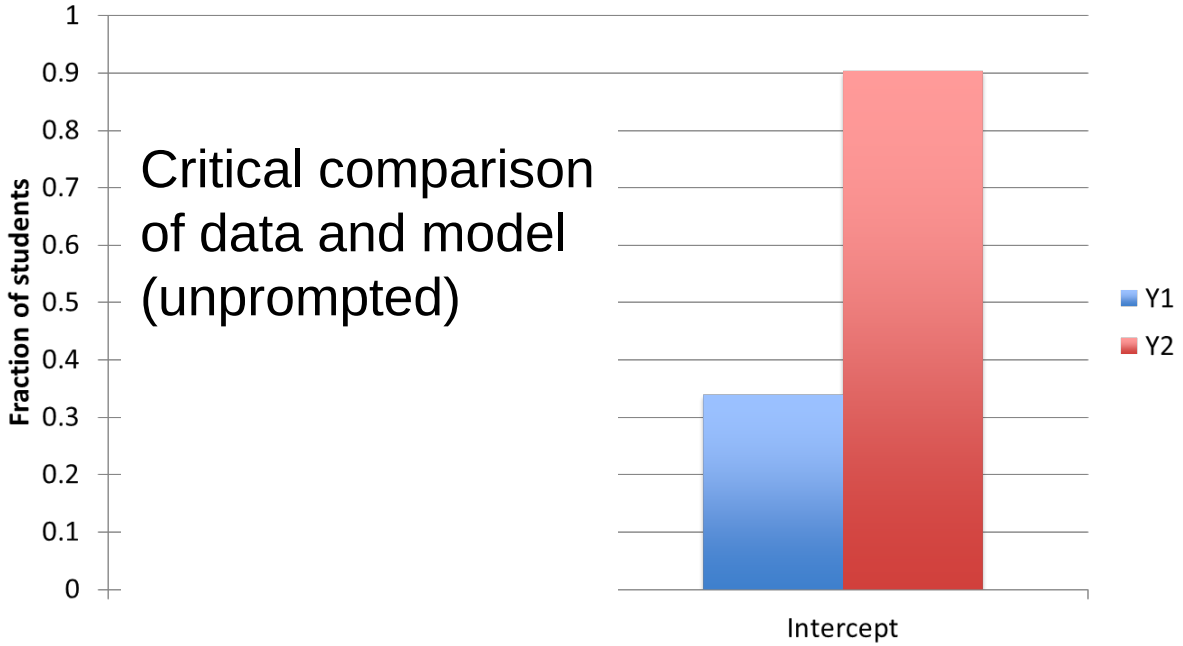


Developing critical thinking skills

PHYS 107/109/Science1 lab

Getting students to reflect on data, modify model, explain discrepancies

Critical comparison of data and model (unprompted)



Earth, Ocean and Atmospheric Sciences

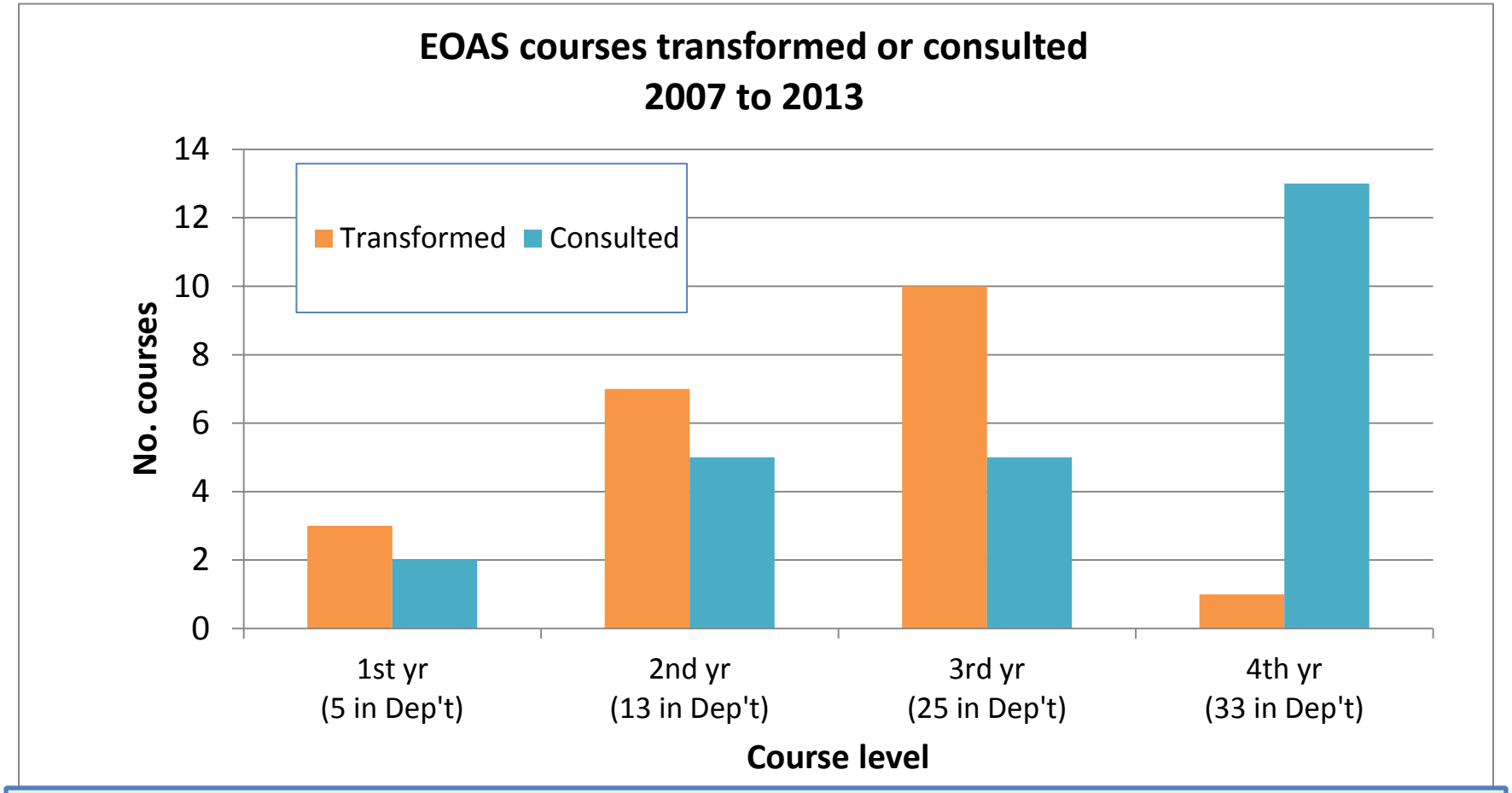
STLFs: Francis Jones & Brett Gilley; CWSEI Dept Director: Sara Harris

CWSEI program in transition phase

- ~80% of EOAS faculty and over half of sessional instructors have received direct support to adjust their courses and teaching from the SEI
- 23 courses have completed transformations, plus another ~15 improved with SEI help; courses ranging from 1st → 4th year, for non-majors & majors
- Gathering & analyzing data on impact
  Teaching Practices Inventory, classroom observations, Student Learning Experiences Survey, student workload data, pre-post test data and other measures of learning, graduating student exit surveys

4 posters

EOAS Courses Impacted



% of courses: 100% 92% 60% 42%

Overall: 61% of dept. courses, greater majority of student-credit-hours. Many faculty now transforming courses on their own.

Overall Impact of CWSEI

100 courses substantially transformed under CWSEI departmental programs

- emphasis on large 1st and 2nd year courses
- additional 37 courses impacted (had some CWSEI input)

15,000 UBC undergraduate students took one or more transformed science courses in 2012

- Science, Engineering, Arts, Business students

What's next? Simon Peacock will tell you about plans