



Carl Wieman Science Education Initiative
at the University of British Columbia

2011-12 End of Year Event

Opening Session 9-11am

Overview of CWSEI activities – Sarah Gilbert, CWSEI Acting Director

Transforming Teaching in Geology

James Scoates, Earth & Ocean Sciences

Teaching Methods Comparison in a Large Intro Calculus Class

Warren Code and Mark MacLean, Mathematics

Student Reflections – what students have to say about transformed courses

Poster session 11am-1:30pm room 101

Details on what's happening (& food)

1:45 – 3:30pm, room 101

“Beyond CWSEI” Discussion – co-sponsored by the FoS Dean's office

What key elements must we preserve to sustain the use of evidence-based teaching methods and drive further improvement of science education at UBC?

Carl Wieman Science Education Initiative

Started 5 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 scale at earlier stages:

Physics & Astronomy

Mathematics

Computer Science

Life Sciences

Smaller scale programs – **Chemistry, Statistics**

\$2 M gift from David Cheriton for Math & Computer Science

CWSEI “Trinity” for each course

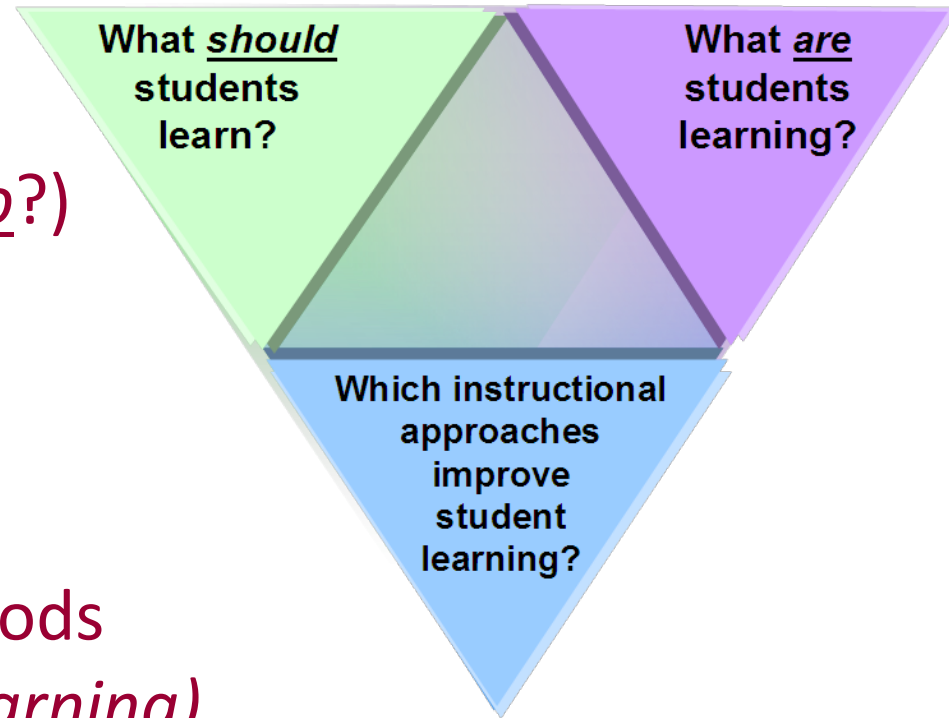
1st: Learning goals. (what should students be able to do?)

2nd: Good assessment
(validated tests)

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

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

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



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-reading assignments & 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 – effective even in large (250 student) classes
- ❖ **Homework problems targeted at learning goals**
- ❖ **Pre-post testing to measure learning, surveys to gauge perceptions about science ...**

Earth & Ocean Sciences

STLFs: Francis Jones & Brett Gilley

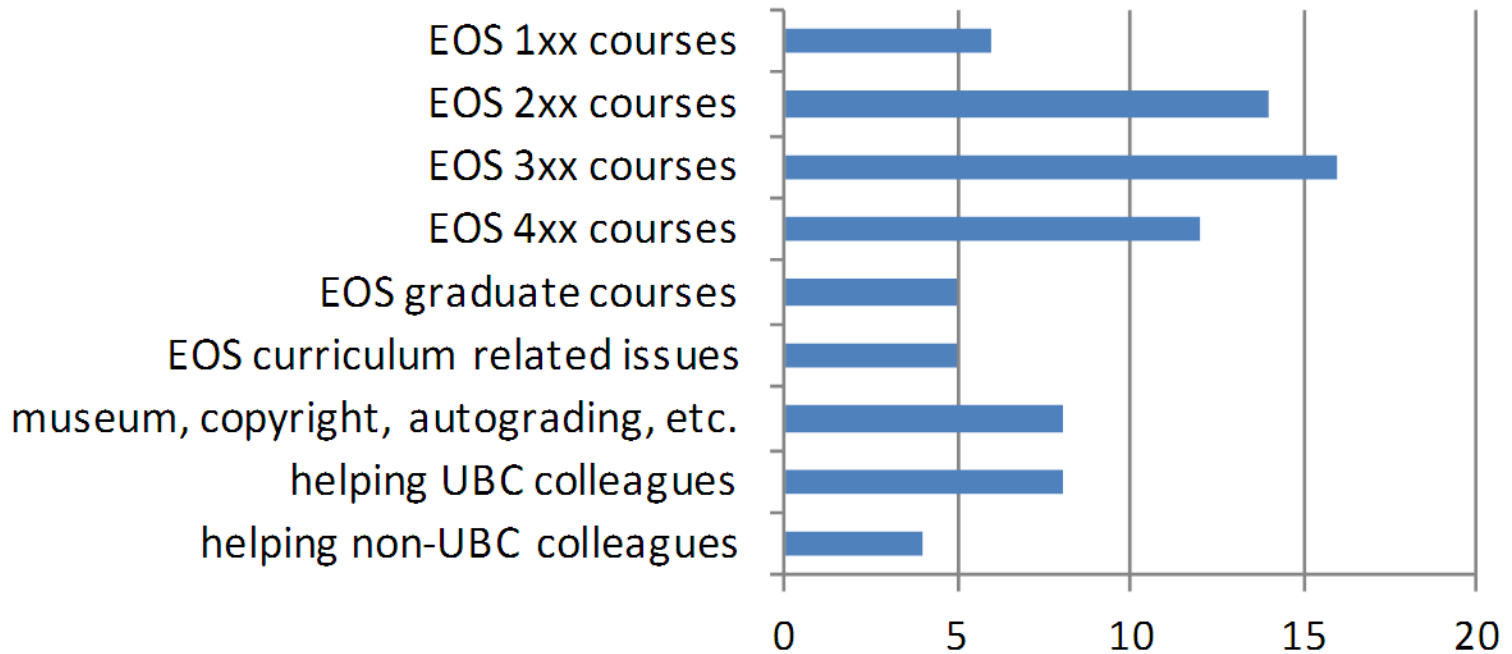
- About 60% of faculty have made substantial changes to multiple aspects of their teaching. Additional 10-15% of faculty have made some changes.
- **23 courses have completed transformations**, plus another ~10 improved with SEI help; courses ranging from 1st → 4th year, for non-majors & majors
- Winding down; shifting focus to “consulting mode” and sustaining changes

4 posters + next talk

EOS STLF Consulting

July 2011 – March 2012

78 consultations in 9 mths involved ...

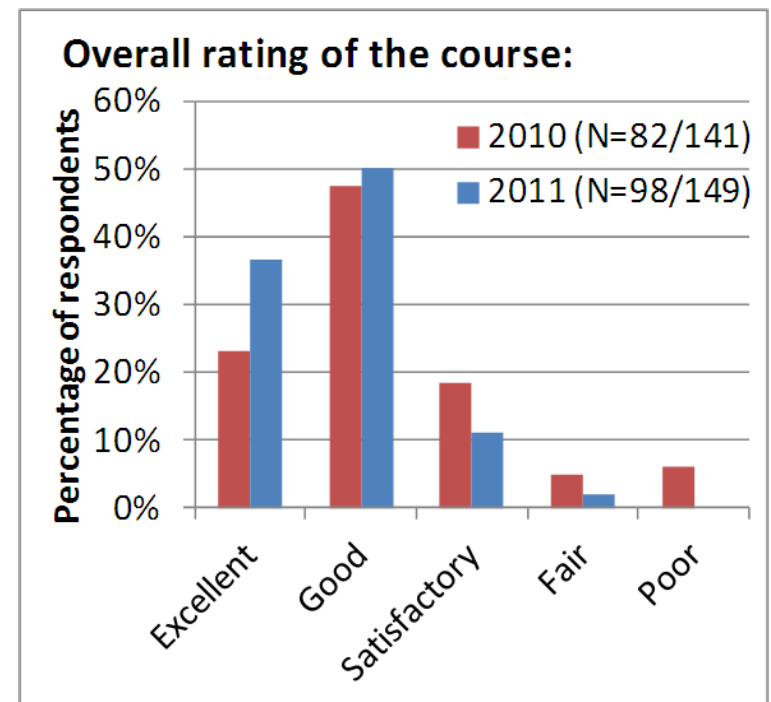
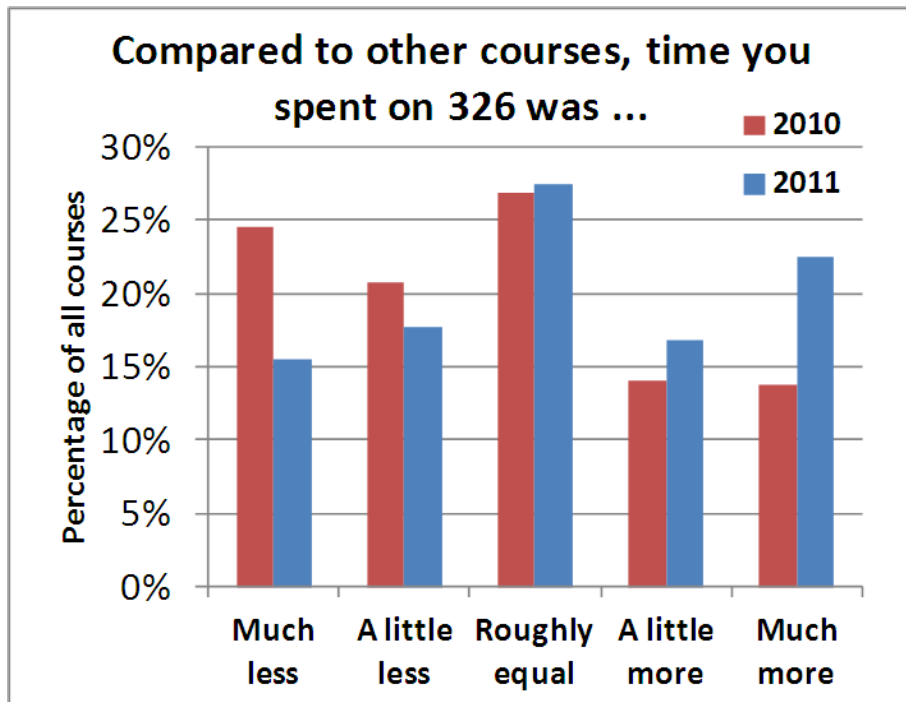


EOSC326, Earth and Life Through time

- Science elective: 150 B.Sc. Students, 3rd or 4th yr.

Work loads from: *98 students in 2011, 82 in 2010*

- Became “harder” in 2011 (but still reasonable)
- AND ... overall rating improved



Physics & Astronomy

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

Working on 15 courses ranging from 1st → 4th year, for non-majors & majors/honors students

- Astronomy courses: *Exploring the Universe I & II*
- Intro Physics courses: *Phys 100, 101, 102, 107, 109, 153*
- Higher level Physics courses:
 - Quantum Mechanics/Modern Physics: *Phys 200, 250, 304, 450*
 - Physics of Materials: *Phys 315*
 - Electromagnetic Theory: *Phys 401*
 - Optics: *Phys 408*
- Some courses have no explicit lecture component anymore

8 posters

Phys 315 Evaluations

Instructor's overall evaluation improved

3.8 *(term before transformation)*

→ **4.3** *(first term doing a transformation)*

Value of Pre-Readings

Louis Deslauriers & Cynthia Heiner

Question Sophistication:

- Students write down questions during class
- 3 courses, ~ 320 students, with and without pre-reading
- Measured fraction of questions at high level of sophistication
Marbach (2000)

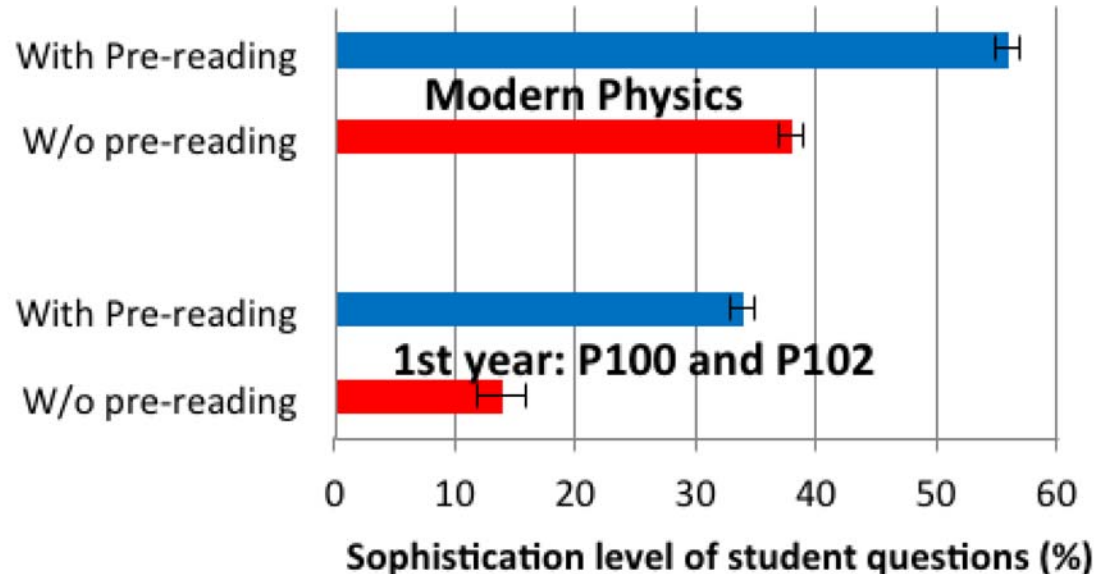
No pre-reading vs. pre-reading with quiz

2nd year modern physics

38 ±2% ⇒ **56 ±2%**

1st year general intro physics

14 ±2% ⇒ **34 ±2%**



Value of Pre-Readings

Louis Deslauriers & Cynthia Heiner

Student quote:

*“The pre-readings were more useful than I thought. It was evident during the week where there was no pre-reading ...
I had much more difficulty understanding the concepts that week”*

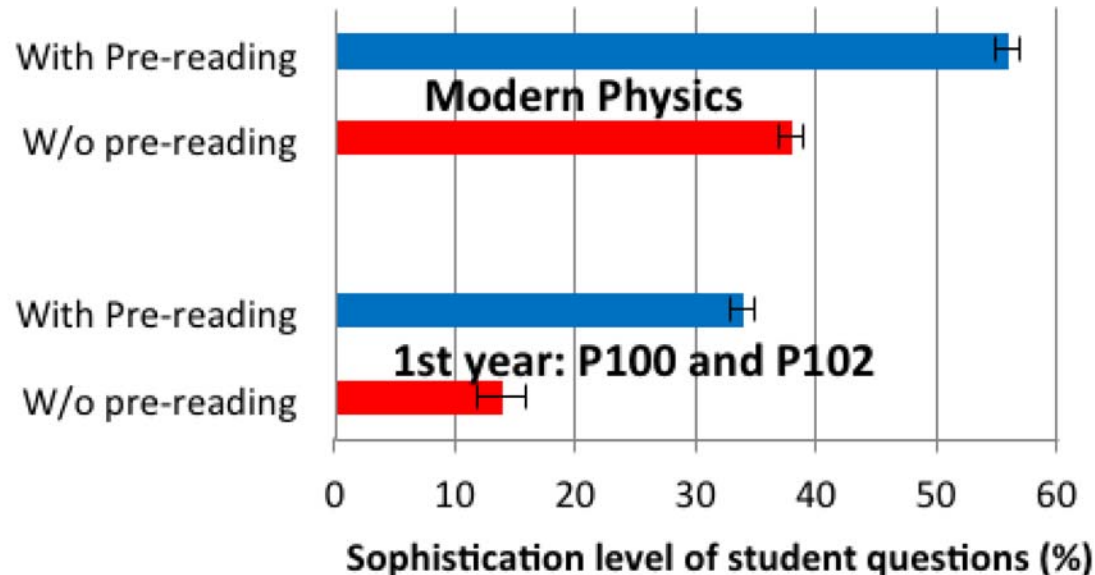
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Life Sciences

STLFs: Jared Taylor, Malin Hansen, Mandy Banet, Bridgette Clarkston, & Lisa McDonnell; CWSEI Dept. Director: Trish Schulte

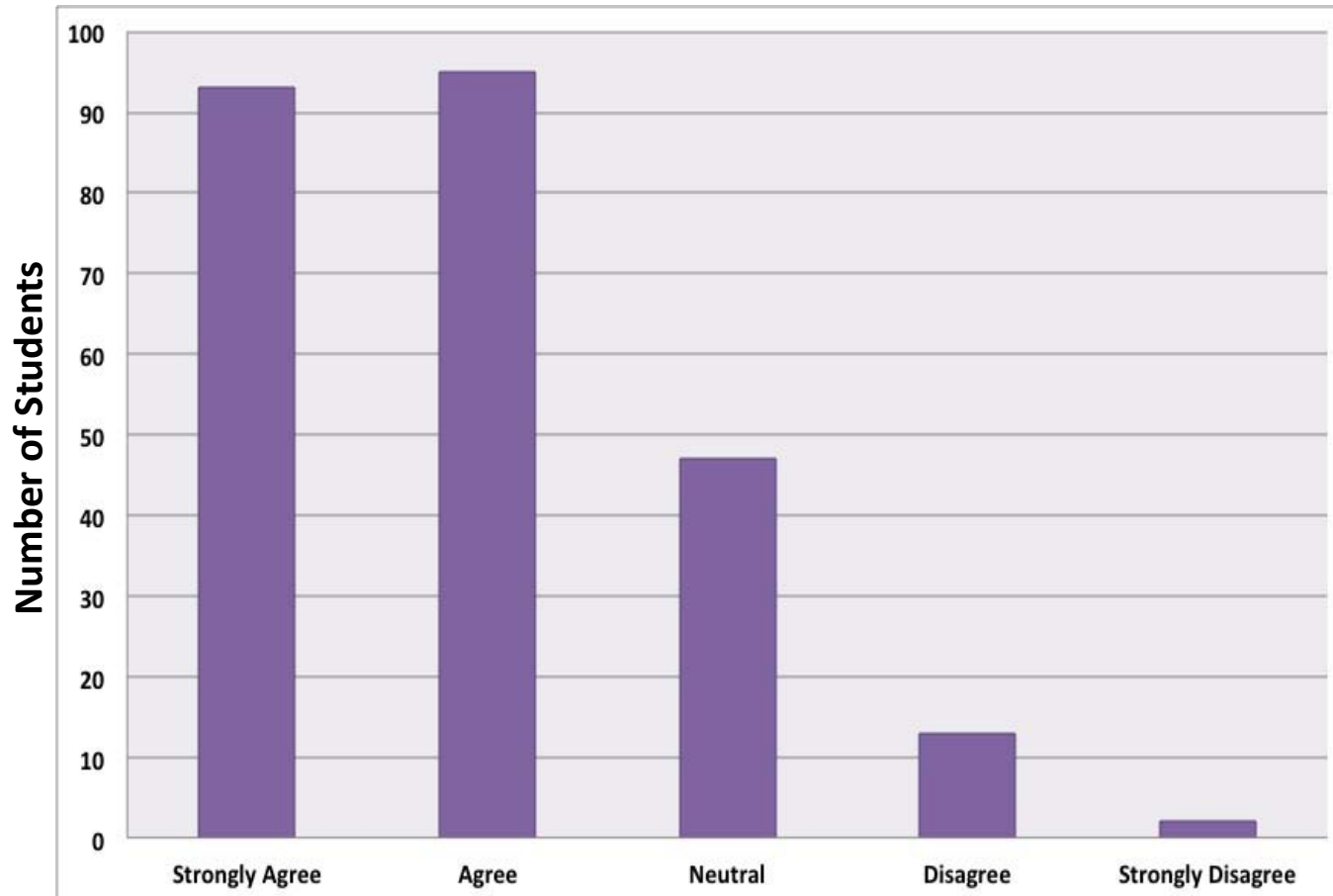
Ramping up!! 3 STLFs hired in last 6 months

- Concentrating on 2nd & 3rd year fundamentals courses in the newly-defined Biology curriculum:
 - Cell Biology
 - Ecology
 - Genetics
 - Physiology
 - Evolution
- Also ongoing work on 1st year courses and 3rd year MICB Microbial Genetics
- Q4B: Big project to produce multiple concept inventories

4 posters

Biology 260 Survey:

I found in-class group worksheets to be helpful to my learning of animal physiology.



“What really motivated me was that the questions really required you to apply the knowledge/theories that were covered in the pre-reading. They are interesting problems and not something discussed in the reading. They did not ask for a straight memorization answer but really had you thinking about the concept!”

Mathematics

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

- Calculus courses – *MATH 110, 104/184, 180/184 workshops*
Talk this morning on an interesting study comparing student learning for different teaching methods
- Computing/computer lab components
incorporating in many courses
- Mathematical Proof – *Math 220*
Developed pre-post test for basic proof skills, incorporating workshop activities into course, plan to track proof skills retention/development in upper level courses
- MATH 230/335: Mathematics for Elementary Teachers
- Mathematics Attitudes Perceptions Survey
- Incorporating online homework in many courses

9 posters

Math 220 Mathematical Proof – Surveys

Asked Students on end-of-term survey:

Do you have any comments about the workshops?

70% of comments positive, additional ~15% provided suggestions for improvement (e.g. more feedback)

"As frustrating as they can be the group work seems to help"

"The workshops were really helpful because it forces me to do questions and give immediate feedback on my progress. I also liked working with others as the interaction allowed me to learn from others and practice explaining things clearly to other people as well"

On midterm survey: Do you find workshops useful?

"Very, great way to challenge yourself and try some more difficult problems"

Computer Science

STLF: Allison Tew; CWSEI Dept. Director: Paul Carter

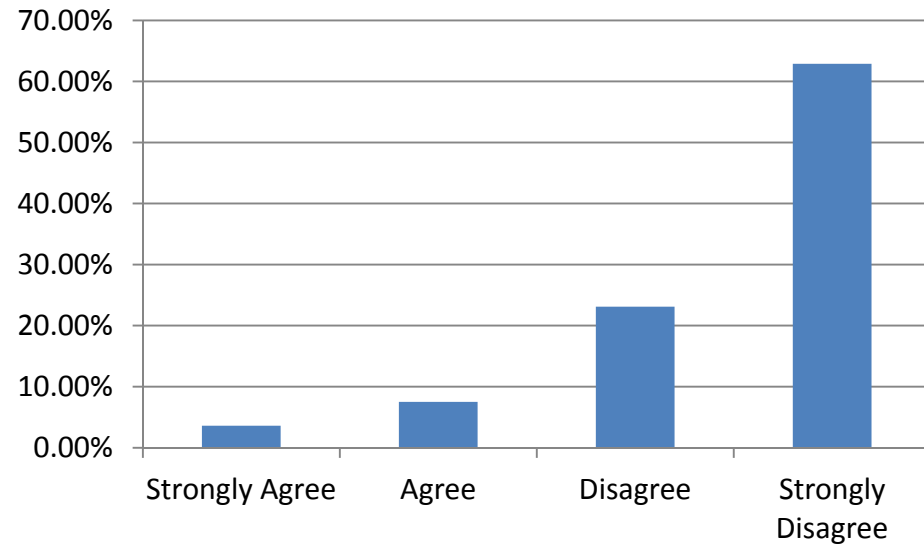
- Working on a wide variety of courses from 1st year → 4th, such as:
 - CPSC 121 Models of Computation: extensive work on course and labs
 - APSC 160 Introduction to Computation in Engineering Design: screencasts to prepare for active classes
 - CPSC 317 Internet Computing: full transformation in progress
- Developed learning goals (both course-level and topic-level) for all 1st & 2nd year core courses
- Planning a longitudinal study of knowledge/skill retention and expertise development in a majors stream
- Developing and validating the Computing Attitude Survey.

5 posters

Student Survey data

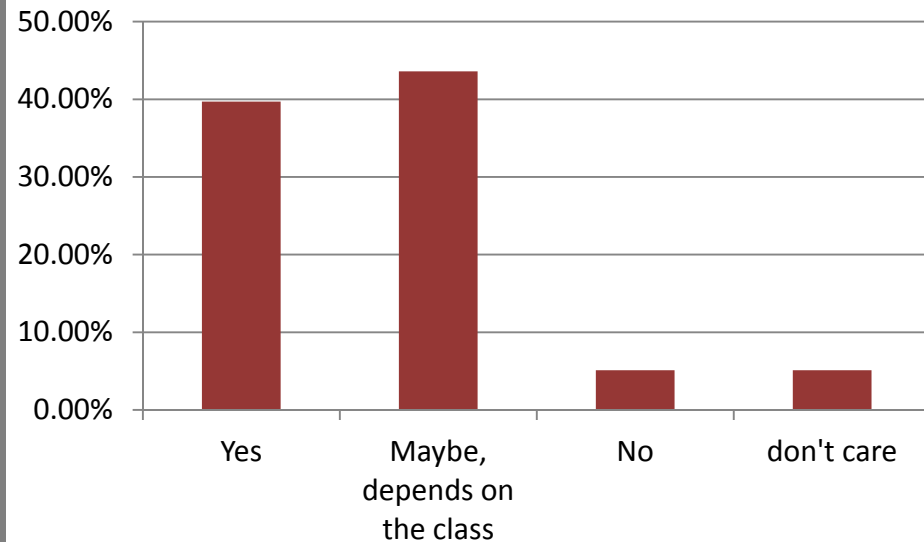
APSC 160

I would prefer that this course be taught using a traditional lecture format rather than having online screencasts and in-class problem sets



CPSC 121

Would you recommend that other instructors in computing courses use clickers with discussion?



Statistics

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

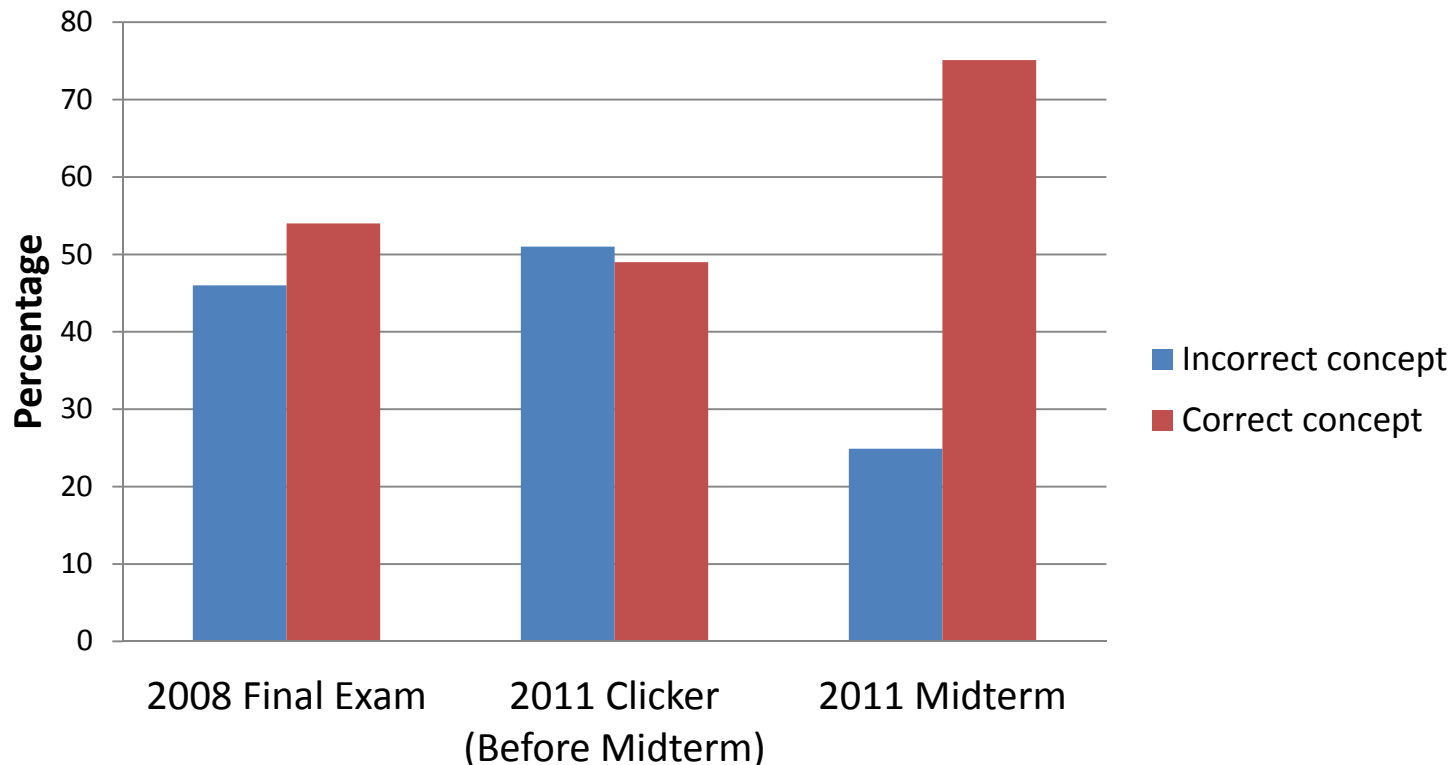
- Working on 3 courses; focus on introductory statistics and introductory probability courses
 - STAT 200: Elementary Statistics for Applications
 - STAT 241/251: Introductory Probability and Statistics
 - STAT 302: Introduction to Probability
- Introducing in-class activities and clicker questions; incorporating context-rich problems, adding homework assignments, improving labs
- 3 other courses now incorporating interactive engagement

1 poster

Overcoming misconceptions in Statistics

Misconception that “everything is normal” in terms of distributions of various random variables.

Instructional improvement: used a clicker question to make the students aware of the misconception and to elicit a discussion, pointing out various additional conditions that need to be verified.





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Lots going on! - talks & posters give more details

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