UBC and CU Science Education Initiatives

models for achieving sustainable change in university science education

Sarah Gilbert,[1] Kathy Perkins,[2] and Carl Wieman[1,2]

[1] Carl Wieman Science Education Initiative, University of British Columbia, Vancouver, BC, Canada; [2] Science Education Initiative and Dept. of Physics, University of Colorado, Boulder, Colorado, USA

Carl Wieman Science Education Initiative at the University of British Columbia

UBC SEI

www.cwsei.ubc.ca

6 year $12 M program (2007—2012); 90% concentrated in Science Departments, 10% more broadly.

Director: Carl Wieman
Associate Director: Sarah Gilbert

Departments

Earth & Ocean Sciences
- Full funding 2007, 4 SES*, 14 faculty involved
- Vigorous leadership and motivated department
- Systematic approach to changing all undergrad education in dept.
- Currently transforming 7 courses & others impacted
- Give teaching reduction for primary faculty changing course
- Developed TA training program; developing attitudinal survey
- In process of determining overall curriculum goals

Life Sciences (Depts. of Botany, Microbiology & Immunology, and Zoology – combined undergrad program 1st 2-3 years)
- Full funding 2007, 4 **SES**, 19 faculty involved
- Organizationally challenging (3 dept. cultures)
- Working on 5 courses & others impacted
- Analyzing biology courses to identify chemistry content
- Assessing overall curriculum – conducting student, alumni, and employer interviews

Physics & Astronomy
- Seed funding 2007, full funding 2008; 3 **SES**, 6 faculty involved
- Working on 3 courses, more soon
- Completely rethinking 1st year lab course – establishing goals …
- Developed TA training program; very successful
- Conducted faculty survey (reflections on courses) and focus groups

Computer Science
- Seed funding 2007, full funding 2008; 1 **SES**, 9 faculty involved
- Developed learning goals for 5 1st & 2nd year courses
- Surveyed faculty & students on usefulness of learning goals
- 1 hyperactive SES can get a lot happening!

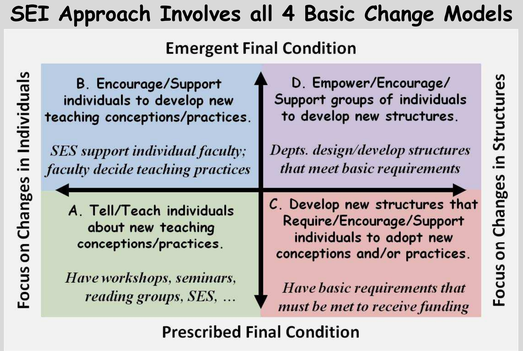
Statistics
- Seed funding 2007, 3 faculty involved
- Transformation of large intro Statistics course: conducted student interviews, developed learning goals, introduced active learning
- 1 faculty member underwent large change in thinking about teaching

Chemistry
- Seed funding 2008, hiring **SES**, plan to work on intro lab
- Lots of good interaction with 1 very motivated member of dept.

Math
- Seed funding 2008, hiring **SES**, developing detailed plan

***SES = Science Education Specialist**

SEI Approach Involves all 4 Basic Change Models

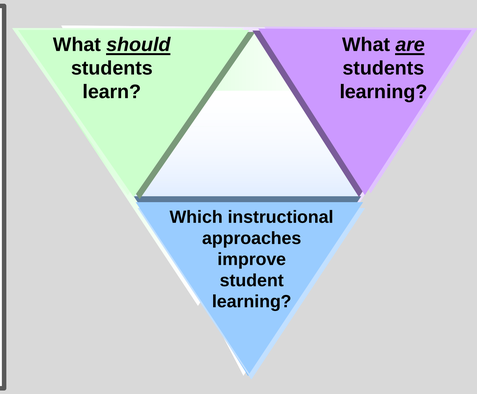


Introduction

The Carl Wieman Science Education Initiative (SEI) at University of British Columbia and the sister SEI program at University of Colorado have as their goal the achievement of sustainable institutional change towards effective, evidence-based science education. These programs fund departments to take a four-step, scientific approach to undergraduate education:

1) **Establish what students should learn;**
2) **Scientifically measure what students are actually learning;**
3) **Use instructional approaches guided by research on learning and measures of student learning;**
4) **Disseminate and adopt what works.**

In this poster, we discuss the design of the SEI change model.



Underlying Reasoning

Logical unit of change is the Department
Department is the cultural unit. Small scale change (one or a few courses involving a few faculty) is an important research step, but does not result in widespread changes in instructional practices. Need change to involve majority of faculty in department.

Change must be driven by department – Faculty are experts in their science fields. The faculty and department as a whole need to decide what students should learn, adopt or develop good measures of relevant learning, and change instructional approaches.

Evidence is key – Most faculty will feel that change is necessary if there is good data showing students aren't getting important ideas/concepts, or evidence of students seeing subject as less interesting and/or useful after taking course.

Additional resources are needed to support the process of change – These changes take faculty time

Effective teaching can be more efficient than current practices (and more fun!)
Re-use of good materials, less repetition/overlap of material, team teaching large courses, effective use of technology, etc. can result in lower resource requirements in long-term.

Approach

Significant 1-time investment of resources at CU and UBC
Concentrated (~1-2 M$/dept. over 5 years) to fund change activities; maintenance of change should not require extra resources.

Departments compete for funding – Criteria: commitment and readiness to undertake widespread sustained effort to improve undergrad education

Science Education Specialists (SES) – Positions funded by SEI; work with faculty to measure learning, change courses, evaluate curriculum, …

Departmental culture change – Need majority of the faculty and courses to be involved and mechanisms to sustain change

Archive, Re-use, Improve materials – Developing SEI course materials archival system

SES Model

See Kathy Perkins' poster:
Department-based Science Education Specialists as agents of change in university education

SES = Science Education Specialist [aka STF at CU (Science Teaching Fellow) & STLF at UBC (Science Teaching & Learning Fellow)]

An SES:
- Is expert in particular science discipline (usually recent PhD),
- Hired by science dept.,
- Given considerable ongoing training & guidance on science education fundamentals by SEI central & other SES,
- Works with faculty to develop learning goals, measure learning, change assessment & instruction…

SEI Central

SES Development
Frequent meetings with considerable effort and emphasis on:
- Development of SES's understanding of how people learn, effective pedagogy, evidence supporting educational approaches
- Science education research base & how to do research
- Effective ways to work with faculty & communication of good practices

Faculty/Department Interactions
- Regular meetings with departmental liaisons, department Heads/Chairs, Dean, some meetings with individual faculty & whole depts.
- Lecture series, workshops (learning goals..), yearly event - SEI activities

Materials Archive System
Developing online course materials archive system:
- Course materials (e.g. lecture notes, clicker questions, assignments, …)
- Instructor comments on use of materials and reflections on course
- Common student difficulties & how to address them

Results so far

Good:

LOTS happening (see lists under depts. on left & right)
rapidly growing # faculty involved, many courses being improved, new data from multiple disciplines on what is working and not.

SES Model works well in many circumstances

Pool of excellent SES candidates out there

A number of examples of spontaneous adoption/involvement
- Individuals trying out new teaching methods with minimal assistance
- Groups tackling curriculum issues following discussions about a course

Help from higher up
UBC Science Dean requiring learning goals for all 1st year courses

Not so good:

Change is hard!
OK, we knew that, but it's harder than we thought; can be frustrating and discourage SESs

Significant minority of faculty resisting (expected)

Particularly difficult when:
- Many faculty teach different sections of same course without coordination (hard to reach consensus)
- Don't have a critical mass of faculty who are open minded about change
- Strong sense of personal "ownership" of course (rather than dept. ownership) & misconception of what "academic freedom" means.

Low opinion of students by some faculty – how to overcome?

The Science Education Initiative at the University of Colorado

CU SEI

www.colorado.edu/sei/

5-year, $5M program (2006—2010); concentrated in selected Science Departments

Director: Carl Wieman
Associate Director: Kathy Perkins
Director of Research: Wendy Adams

Departments

Chemistry & Biochemistry
- 2 **SES***, 8 faculty involved
- Concentrating on General Chemistry I & II: large enrollment—high impact on a variety of science majors.
- Developed learning goals
- Developed recitation tutorials – emphasize conceptual understanding
- Developed & implemented TA training program
- Developing/revising concept inventories

Geological Sciences
- 3 **SES**, 16 faculty involved
- Working on 5 courses; implementing active learning techniques
- Developing learning goals, developing/revising concept inventories
- Developed Geology version of attitudes survey; collaborating w/ UBC on earth/atmospheric/ocean sciences version
- Identifying common student difficulties

Integrative Physiology
- 2.5 **SES**, 11 faculty involved
- Major changes in 5 courses, 9 others impacted
- Systematic evaluation of entire curriculum
- Developed/refining learning goals in 4 courses
- Developing & implementing pre-post assessments with emphasis on conceptual knowledge
- Implementing clickers & other active learning techniques
- Collaborating w/ MCDB on developing biology attitudes survey
- Large departmental changes in thinking about teaching

Molecular, Cellular, & Developmental Biology
- 2 **SES**, 10 faculty involved
- Working on 5 courses
- Developing aligned learning goals for entire core curriculum (5 courses)
- Developing pre/post assessments for Molecular & Cell Biology and Genetics covering key learning goals
- Collaborating w/ IPHY on developing biology attitudes survey
- Conducting several research projects

Physics
- 2 **SES**, 11 faculty involved
- Major transformation of 3rd year Electricity & Magnetism course, incorporating clickers/active learning that emphasize conceptual understanding
- Developed learning goals and post-course assessment tool
- Identifying common student difficulties
- Next: start on 3rd year Quantum Mechanics

***SES = Science Education Specialist**