



Carl Wieman Science Education Initiative

Achieving highly effective university science education

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Introduction

The Carl Wieman Science Education Initiative (CWSEI) is a 6-7 year program (2007—~2013) at the University of British Columbia aimed at achieving sustainable institutional change towards effective, evidence-based undergraduate science education. This program funds departments to take a 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;

In this poster, we discuss the design of the SEI model and the departmental activities.

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

Concentrated (~1-2 M\$/dept. over 6 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 Teaching & Learning Fellows (STLF) – Temporary positions funded by CWSEI; 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

SEI Central

STLF Development

Frequent meetings with considerable effort and emphasis on:

- Development of STLF'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 CWSEI departmental Directors, department Heads/Chairs, Dean, some meetings with individual faculty & whole depts.
- Lecture series, workshops (learning goals..), yearly event - SEI activities

Materials Archive System (sei.ubc.ca)

Developed online course materials 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

What should students learn?

What are students learning?

Which instructional approaches improve student learning?

STLF Model

Department-based Science Teaching & Learning Fellows as agents of change in university education

STLF = Science Teaching and Learning Fellow

An STLF:

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

Examples:

- Facilitate course working groups (group of faculty teaching course and subsequent course if applicable) – develop learning goals and pre-post assessments
- Gather data on student thinking about topics (difficulties, misconceptions) via interviews, analyzing exams, homework, conducting & observing informal problem solving sessions, listening to student discussions during in-class activities, pre-post concept tests and attitudinal surveys ...
- Develop course materials with faculty
- Serve as department resource on pedagogy – ranging from casual discussions to conducting seminars/workshops



Departmental Activities

www.cwsei.ubc.ca/departments

Typical new aspects incorporated in courses (each course will not necessarily have all of these):

- ❖ Clearly articulated learning goals for students & faculty
- ❖ Pre-reading assignments & quizzes
- ❖ Efforts to increase student interest and motivation to learn subject
- ❖ Interactive engagement targeted at learning goals (deliberate practice to develop expertise)
 - Clicker questions and peer discussion – especially in large classes
 - 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

- Full funding 2007, currently 2 **STLFs**, over 70% of faculty have used SEI support to improve their teaching, and the majority have made substantial changes to multiple aspects of how they help students learn
- Systematic approach to changing undergrad education
- Completed 23 course transformations & 10 more courses "unofficially" improved
- Many faculty spontaneously incorporating interactive engagement in other courses
- Program now concentrating on consultations and sustainability
- Developed TA training program and attitudinal survey
- Conducted exit survey of graduates & employer survey
- In process of determining curriculum goals for different majors streams

Physics & Astronomy

- Seed funding 2007, full funding 2008; currently 4+ **STLFs**, ~25 faculty involved
- Working on 15 courses, 1st year – 4th year
- Developed successful TA training program
- Administered extensive diagnostic testing of conceptual understanding
- Several extensively transformed courses (little or no lecturing), including 1st year and upper level courses.
- Developed learning goals for electricity and magnetism multi-year curriculum

Math

- Seed funding 2008, full funding 2010, currently 4 **STLFs**, ~14 faculty involved
- Calculus courses undergoing transformation; developed learning goals, incorporating interactive engagement
- Assessed & improved calculus workshops and computer labs in 6 courses
- Proofs skills: developing pre-post diagnostic, plan to track development & retention of proof skills & expertise through curriculum
- Incorporating online homework in multiple courses

Life Sciences (Depts. of Botany, Microbiology & Immunology, and Zoology)

- Funding 2007, recent ramp-up of efforts to full program level, currently 5 **STLFs**
- Concentrating on 2nd & 3rd year fundamentals courses in the newly-defined Biology curriculum: Cell Biology, Ecology, Genetics, Physiology, and Evolution
- Developing numerous tests of conceptual understanding

Computer Science

- Seed funding 2007, full funding 2008; currently 1 **STLF**, ~25 faculty involved
- Working on courses ranging from 1st to 4th year level
- 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
- In the process of developing and validating the Computing Attitude Survey.

Chemistry

- Seed funding 2008, 3 faculty involved
- Concentrated on evaluation and redesign of large first year lab courses – extensive assessments developed
- Developed lab learning goals
- Implemented modified TA training
- Administered C-LASS CHEM (Attitudinal Survey) in multiple courses

Statistics

- Seed funding 2007, currently 1 **STLF**, ~5 faculty involved
- Working on 3 courses with focus on introductory statistics and introductory probability courses
- Conducted student interviews, developing learning goals, administered pre and post term student attitude surveys, introducing in-class activities and clicker questions
- Incorporating context-rich problems, adding homework assignments, improving labs
- 3 other courses now incorporating interactive engagement

Good:

LOTS happening (see above list of activities) rapidly growing # faculty involved, many courses being improved, new data from multiple disciplines on what is working and not.

STLF Model works well in many circumstances

Pool of excellent STLF 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 & Provost very supportive

Not so good:

Change is hard!

OK, we knew that, but it's harder than we thought; can be frustrating and discourage STLFs

Significant minority of faculty resisting (expected)

Particularly difficult if:

- 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 department ownership)
- Faculty lay all the blame for lack of learning on students

Tyranny of content – some faculty think that "covering" material is the same as "teaching" it