The Carl Wieman Science Education Initiative (CWSEI) is a six-year, $12M program (2007–2012) 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 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 model and the departmental activities.

**Introduction**

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**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 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 undergraduate education.

Science Teaching & Learning Fellows (STLF) — Positions funded by CWSEI; work with faculty to measure learning, change courses, evaluate curriculum, ... Departmental culture change — 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.

**STLF Development**

Frequent meetings with considerable effort and emphasis on:
- Development of STLFs 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**

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 
- External review of materials — how to address them

**Departmental Activities**

**Earth & Ocean Sciences**
- Full funding 2007, 4 STLFs, 17 faculty involved
- Vigorous leadership and motivated department
- Systematic approach to changing all undergrad education in dept.
- Currently "officially" transforming 12 courses & 9 more courses "unofficially" being improved
- Over 60% of EOS faculty are involved in the SEI in some capacity (committees, working groups and/or making changes to their courses)
- Give teaching reduction for primary faculty changing course
- Developed TA training program and attitudinal survey
- In process of determining overall curriculum goals

**Life Sciences**
- Deps. of Botany, Microbiology & Immunology, and Zoology — combined undergrad program 1st-2nd years
- Full funding 2007, 2 STLFs, 22 faculty involved
- Organizationally challenging (3 dept. cultures)
- Working on 6 courses & others impacted
- Developing learning outcomes for several upper level courses
- Gathering a variety of data to inform their curriculum design: 4th year Biology Satisfaction Survey, Attitudinal Survey, Ecological Attitude Survey, Concept Tests, Focus Group Interviews, etc.

**Physics & Astronomy**
- Seed funding 2007, full funding 2008; 3 STLFs, 11 faculty involved
- Working on 2 courses
- Developed TA training program; very successful
- Administered extensive diagnostic testing of conceptual understanding
- Developed course database system to archive course materials
- Conducted faculty survey (reflections on courses) and focus groups

**Computer Science**
- Seed funding 2007, full funding 2008; 3 STLFs, 14 faculty involved
- Working on 7 courses, ranging from 1st to 3rd year level
- Developed learning goals (both course-level and topic-level) for all 1st & 2nd year core courses
- In process of exploring how students' ability to communicate about code changes during their core courses

**Statistics**
- Seed funding 2007, 3 faculty involved
- Working on 4 courses
- Transformation of large intro Statistics course:
  - STLFs working on workshops and computer labs in 6 courses
  - Students seeing subject as less interesting and/or useful after taking course.

**Chemistry**
- Seed funding 2008, 1 STLF, 6 faculty involved, and collaboration with Skylight Research Associate
- Concentrating on evaluation and redesign of a first year lab course
- Implemented the first round of modified TA training
- Administered C-LASS CHEM (Attitudinal Survey) in multiple courses
- In process of revitalizing undergraduate laboratory for years 2-4

**Math**
- Seed funding 2008, 2 STLFs, 5 faculty involved
- Working on workshops and computer labs in 6 courses
- Working to assess the effectiveness of the workshops and assist in the study of how well the basic skills test predicts success in the course.

*STLF= Science Teaching and Learning Fellow

**Good:**

LOTS happening (see above list of activities) rapidly growing if 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/innovation
- 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 STLFs

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 department ownership) & misconception of what “academic freedom” means

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

**User Guide**

- STLF: An 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.

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

- STLF Model

- SEI Central

- www.cwsei.ubc.ca/departments

- www.cwsei.ubc.ca

- Carl Wieman, Director & Sarah Gilbert, Associate Director

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