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.

**SEI Central**

**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 (sei.ubc.ca)**
- Developed online course materials system:
  - Course materials (e.g. lecture notes, clicker questions, assignments,…)
  - Instruct comments on use of materials and reflections on course
  - Common student difficulties & how to address them

**Approach**

- Logical unit is the Department
  - Department is the cultural unit. Small scale change could be a few courses involving a few faculty
- 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 materials, team teaching large courses, effective use of technology, etc. can result in lower resource requirements in long-term.

**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 undergraduate 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.
- Arch, Re-use, Improve materials – Developing SEI course materials archival system

**Departmental Activities**

**STLF Model**

**What should students learn?**

- Developed TA training program and attitudinal survey
- Conducted exit survey of graduates & employer survey
- Seed funding 2008, 3 faculty involved

**What are students learning?**

- Incorporating online homework in multiple courses
- Developed course materials
- Administered C

**Which instructional approaches improve student learning?**

- Faculty lay all the blame for lack of learning on students
- Many faculty spontaneously incorporating interactive
- Course materials (e.g. lecture notes, clicker questions, assignments, …)
- Concentrating on 2
- Full funding 2007, currently 2
- Several extensively transformed courses (little or no

**STLF** Science Teaching & Learning Fellows as agents of change in university education

- STLF = Science Teaching and Learning Fellow
- An STLF:
  - 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 seminar/workshops

**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 of changing undergraduate education
- Completed 23 course transformations & 10 more courses “unsatisfactorily” 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
- Process in determining curriculum goals for different majors streams

**Physics & Astronomy**

- 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 Atom Model

**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-diagnostic, plan to track development & retention of proof skills & expertise through curriculum
- Incorporating online homework in multiple courses

**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, producing in-class and clicker questions
- Incorporating context-rich problems, adding homework assignments, improving labs
- 3 other courses now incorporating interactive engagement

**Good:**

- LOT’S 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 & Provost very supportive

**Not so good:**

- Change is hard!
- OK, we knew that, but it’s harder than we thought; can be frustrating and discouraging

**Lack of change!**

- While faculty think that “covering” material is the same as “teaching” it

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www.cwsei.ubc.ca/departments