The Carl Wieman Science Education Initiative (CWSEI) began in 2007 at the University of British Columbia, with the goal of achieving sustainable institutional change towards effective, evidence-based undergraduate science education. This $10.5M 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;

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 matter less interesting and/or useful after taking course.
Additional resources are needed to support the process of change – These changes take faculty time.

Nearly all faculty members want to teach well, but lack expertise - Needs approach.

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

The model developed for the CWSEI and CU-SEI (at CU-Boulder) was guided by the research on what factors facilitate and inhibit the spread of innovations and organizational change, particularly the work of Everett Rogers on the adoption of innovations and the work of John Kotter on organizational change. Everett M. Rogers, Diffusion of Innovations, 5th ed. (New York: Free Press, 2003). John P. Kotter, Leading Change (Boston: Harvard Business Review Press, 1996).

Significant 1-time investment of resources
Concentrated (~1-2 M/dep. 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.

Archive, Re-use, Improve materials – Developed SEI course materials system

STLF Development
Frequent meetings with considerable effort and emphasis on:
- Development of STLF’s understanding of what 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
- Sharing of effective strategies

Faculty/Department Interactions
- Regular meetings with CWSEI departmental Directors, department Heads/Chairs, Dean, some meetings with individual faculty & whole depts.
- Lecture series, workshops, yearly event – SEI activities

Developed Course Materials Archive System (seil.ubc.ca)

Lessons Learned

Science education specialists (STLFS) embedded in departments – proved to be a highly effective way to provide the necessary knowledge, expertise, and time-saving assistance.

Competitive grant program – focused attention and sparked discussion and planning.

Oversight of departments and requiring specific commitments and timelines – kept priority high.

Focus on changing willing faculty members rather than particular courses – Work on whatever courses willing faculty are teaching. Having a few good examples in the department helped bring others along.

Some Major Issues

The formal (dis) incentive system – THE dominant barrier to the adoption of better teaching methods. Any time taken away from research is viewed negatively.

Difficult to establish a sense of urgency about educational improvement – Kotter’s work on organization change says a sense of urgency important.

Rewarding personal experience more important than data – We thought science faculty would be persuaded by data on student learning, but interacting with engaged students was more persuasive to most faculty.

Major Successful Components

Developed Course Materials Archive System
- Developed SEI course materials system
- SEI Resources: www.cwsei.ubc.ca/resources

CWSEI Central
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- CWSEI website development – resource available to all
- Developing future leaders in science education (over 50 STLFS)
- Adoption of the STLF model at numerous other institutions (Cornell, U. Kansas, Washington U, Stanford, …)


SEI Resources: www.cwsei.ubc.ca/resources
- Instructor guidance, student guidance, clickers, videos, learning goals, tools such as COPUS and TPI, course transformation & STLF development, recommended papers, …

SEI papers & presentations: www.cwsei.ubc.ca/SEI_research

Resources

For about $60,000:
- One faculty member’s change in teaching practices and participation in a teaching and learning project (in many cases, a portion of money went directly to buying faculty time), plus
- One course extensively using evidence-based practices, plus
- Student learning and/or attitudes data in that course, plus
- One published, peer-reviewed talk/poster or journal article.

And contributed to:
- Accumulated culture change in teaching & learning in departments
- CWSEI website development – resource available to all
- Developing future leaders in science education (over 50 STLFS)
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STLFS OVER TIME, COLOR-CODED BY DEPARTMENT (over 50 STLFS)

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

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...
- Help develop course materials – in collaboration with faculty
- Serve as department resource on pedagogy – ranging from casual discussions to conducting seminars/workshops

How much will it take away from research? – it took about 50 hours of deliberate effort for a faculty member to learn new way of teaching.

Will it hurt my student evaluations? – common misconception, but evaluations did not go down on average

How will I cover all the material? – if content not too bloated, use of strategies like pre-reading worked well.

What should students learn?

What are students learning?

Which instructional approaches improve student learning?