Large-Scale Change across Science Departments: Embedded Expertise in Evidence-Based Teaching

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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 as less interesting and/or useful after taking course.

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

Nearly all faculty members want to teach well, but lack expertise - Needs to be recognized that effective teaching requires acquired expertise.

Effective teaching can be more efficient than current practices (and more fun)! – Use of materials, less repetition/overlap of material, 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 CI-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.


Catching the Wave (2010, 2011) – we thought science faculty would be persuaded by data rather than particular courses – Work on whatever works.

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 were teaching. Having a few good examples in the department helped bring others along.

Impact on Teaching by Department, 2015

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Total: 180 faculty, 164 courses, ~140,000 students-ex-credit hrs/yr (~50%)

Physics & Astronomy, Statistics, Computer Science Departments

Combined: 76 faculty changed the way they teach, 61 courses & ~51,000 student-credit hours changed.

Earth, Ocean & Atmospheric Sciences (EOAS) Department (the post-credit)

~43 faculty changed the way they teach, 27 courses & ~35,500 student-credit hours/year changed.

Biology Program (3 departments)

~43 faculty changed the way they teach, 48 courses & ~15,000 student-credit hours/year changed.

Many faculty spontaneously incorporating interactive engagement in other courses

Now have a paired teaching arrangement for new faculty

Quantified the use of effective teaching practices using the Teaching Practices Inventory

 Relevant resources:

1) Science Faculty: 

a. Developed STLF course materials system
b. STLF Model – 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

2) Departmental culture change

- Need majority of the faculty and courses to be involved and mechanisms to sustain change

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Lessons Learned

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 – Kotters work on organizational change says a sense of urgency important.

Surprise

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.

How much time 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 directly to buying faculty time, plus

Frequency of Faculty Concerns

Resources


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, …)

CWSEI departmental accomplishments details: www.cwsei.ubc.ca/departments

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

For about $60,000:

- One faculty members 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 conference 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)
- Adoption of the STLF model at numerous other institutions (Cornell, U. Kansas, Washington U, Stanford, …)