



The Science Education Initiative  
at the University of Colorado



Carl Wieman Science Education Initiative  
at the University of British Columbia



## The Science Education Initiatives at *University of British Columbia*

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*& University of Colorado*

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posters

### Experiments in institutional change

1. Goals and brief description
2. Underlying ideas/rationale for design (discussion)
3. Some early results and observations

#### SEI Overall Goals

1. The faculty will be using research-based teaching methods and measurements of learning in all undergraduate courses in an effective way.

2. There will be formal and informal systems in place to encourage and support instructors carrying out goal #1.

Lots of SEI subgoals part of the overall goals

*"There is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success, than to take the lead in the introduction of a new order of things. For the reformer has enemies in all those who profit by the old order, and only lukewarm defenders in all those who would profit by the new order, this lukewarmness arising partly from fear of their adversaries ... and partly from the incredulity of mankind, who do not truly believe in anything new until they have had actual experience of it."*

– Machiavelli

### SEI finding #1

IS EXACTLY CORRECT-- works for **faculty**,  
administration, students, alums, NSF reviewers, ...

### Change strategies of the SEIs

- Incentives at level of both the individual and the relevant unit for change ("external buy in")
- Need to achieve widespread sense of dissatisfaction with status quo. Something wrong, or could be better. ("internal buy in")
- Must have institutional systems to support change. All levels important, local is most important.
- All of the above must fit with larger community culture (values, standards, ...)
- Change requires investment (time, ... =\$\$\$)

Ref. *Leading Change*, Kotter. 8 steps have to have, 8 common modes of failure. Predictions perfect so far.

### How SEIs being implemented

- 5 departments, selected competitively on basis of proposals. Commitment and readiness to pursue goals.
- Focused \$\$\$ (\$1-2 M) and guidance to **Department**. Support over 6 yrs-- then self-sustaining (no ongoing extra \$\$) **one-time investment**⇒ **permanent impact**

"Hands-semi-on" funding agency

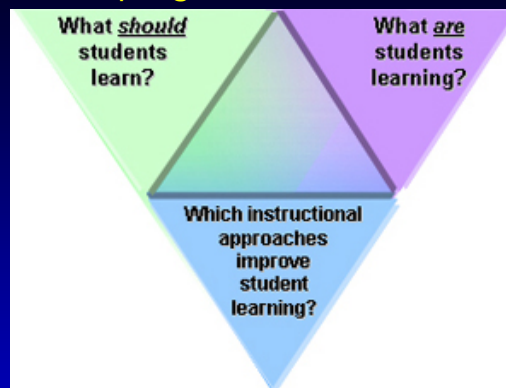
### Department- For each course & program offered

1<sup>st</sup>: Decide on learning goals. (what should students be able to do?)

2<sup>nd</sup>: Rigorously assess student learning on an ongoing basis.

3<sup>rd</sup>: Apply research-based teaching techniques to improve student learning. Measure progress!  
(technology to improve effectiveness & save time)

Ensure materials, data, assessment tools, software,... saved, reused, improved. *(like scientific research)*



*semi-hidden change*

Student learning to become **departmental** rather than individual instructor responsibility

### CU SEI-

Started ~ 9/05? Molec. and cell bio, Geology, Chem. & Biochem., Integrative Physiology. (\$0.5-1 M)

Added physics ~ 07

### UBC SEI-

Ramping up funding

Stage 1 (1/07): Earth and Ocean Sci., Life Sciences,

Stage 2 (~1/08): Physics, Math, computer science

\$1.5-2 M (*from funding to action ~ 6 months*)

*seed projects in, statistics (07), chemistry (08)*

*Broader spread– (nursing, ECE, ...??)*

Not required or expected, but most of \$\$\$ and activity using "science education specialist" approach.

*KP poster--SES expert in discipline, trained in sci. ed. Work with faculty to implement changes in teaching and assessment.*

## Ultimate goal...

### SEI model for all universities

#### Why should Large State U copy?

- 1) convincing data that improves student learning
- 2) responds to calls for accountability-- shows what students are learning per course and program
- 3) market pressures-- Neighboring State U. "See what our students learn, see best practices we are following, unlike Large State U."

#### How we make it cheaper for Large St U?

- online data base of new designed courses, materials, assessment tools, evidence, etc. freely available.

interactive part

## Exploring the underlying ideas & rationale for approach

A. Some questions I thought answers completely obvious (but were not to NSF reviewers).

B. Other ideas not so obvious (or correct?)

R1. What institutional type would provide the most useful demonstration model for postsecondary educational change? (e.g. community colleges, elite 4 year liberal arts, research universities, ...)

*Major research universities train the teachers and teachers of the teachers. Set model and standards for science education. Public research university best model, because poorer.*

R2. What is the optimum unit for change?  
(changing practices, beliefs, etc. =educational culture)  
Optimum allocation of resources to support change?

*Support individuals scattered across as many different disciplines and institutional types as possible?  
Something else?*

R2. What is the unit for change?

The department (in research university).

*In research universities, science departments decide what gets taught, who teaches it, how it is taught. If want change at that grain size, must focus resources to match.*

R3. Has such a transformation of department educational culture already been achieved in many science departments at numerous major research universities?

R4. Is it inconceivable that such change could happen?

R4a. Are most faculty at research universities completely unconcerned with what their students are or are not learning?

Clearly are concerned. Spending MANY hours preparing lectures & arguing over curriculum.

Is conceivable. Major culture change in science dept's has happened before. (Once?)

Teaching colleges ⇒ research universities (How?)

R5. Is it possible to be more effective/teach better without requiring more instructor time?

Are many opportunities to improve efficiency, with and without use of technology!! (see 4a)

R6. How much should it cost?

Can't you change the culture of a major science dept. for \$100-200 K, instead of \$1-2 M+?

Change costs time=money.

Industry-- major shift involves 5-10% or more reallocation of annual budget.

SEI based on 5% annual budget for 5 yrs--

Looks about right.

- 1) Gets full department attention,
- 2) Roughly (?) covers cost of labor required to transform most courses (= involve most faculty).

### Critical elements to drive departmental culture change

- **Incentives at individual and departmental level.**  
*Otherwise never overcome ability of old (or young) curmudgeon to block change.*  
*Machiavelli was right!*
- **Leadership! Departmental level & above**
- **Focused resources-- change takes time = money**  
Put the resources where want results.

Other underlying ideas-- not so obvious (or correct?)

1. Much easier to get people to adapt existing culture/identity than invent new one.

*(scientist-- teaching as scientific activity with data and research based principles and practices)*

2. PER has had impact on instruction.

Primary Drivers:

- backed by data and publications,
- fairly good easy to use standard assessment tools
- topic and course specific proven interventions, many easy to incrementally adopt
- advocates who know subject, speak same language

3. Evidence is necessary.

*(although far from sufficient)*

4. Competing for funding drives change MUCH better than simply making resources available.

5. Require good measurement of learning, but emphasize the department decides on what should be learned and develops/accepts the assessment instruments, chooses what pedagogical approaches to adopt (**as long as assess**).

Acknowledges their expertise and ownership.

### 3. What have we learned so far from SEI experiments?

#### **I. Some aspects working well--**

- Extensive dept-wide conversations on undergrad ed.
- Meaningful learning objectives being developed and assessments being rethought (but slooowly) (but 1/2 the battle)
- Many faculty and courses changing (dozens)
- Many long overlooked opportunities for improvement and streamlining clearly emerging
- Faculty members enjoy talking to each other about teaching in substantive ways--provide forum
- Steadily growing number of converted faculty who can be wonderful advocates

#### **II. some major challenges**

1. Tyranny of content--  
*respond with data on learning ?*  
*looking at needs of upper level and employer/alumni ?*
2. Threatening to some instructors in unexpected ways
3. "Students worthless, don't belong in college. Lazier, less well prepared, ... than last generation"
4. Individual course ownership
5. Getting people to see that better instruction does not equal more work. Are ways to save time. It's *ok* to use somebody else's material.

### III. Some neutral lessons

1. Lots of little stuff is important.

- Teaching assignments
- TA requirements and training, ...

2. Very high degree of similarity and challenges across the two universities and the various disciplines.

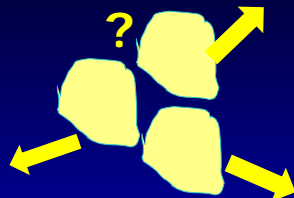
What basic differences there are between universities are smaller than differences between disciplines.

### 3. Discipline related cultural oddities (from $N=2 \Rightarrow \infty$ )

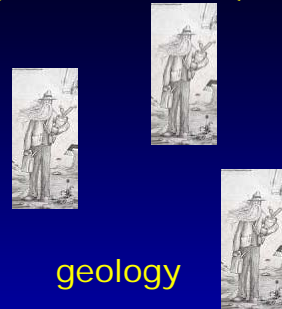


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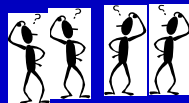
chemistry



biology



geology



Computer science

C.S.  
education???



Can't teach  $x$ ,  
until cover  $a$ ,  
 $b$ ,  $c$ ,  $d \dots t$ ,  $u$ ,  
 $v$ , and  $w$ !

Physics

a work in progress-- stay posted

[www.cwsei.ubc.ca](http://www.cwsei.ubc.ca)

[www.colorado.edu/sei/](http://www.colorado.edu/sei/)

extra slides below

#### EI Overall Goals

1. The faculty will be using research-based teaching methods and measurements of learning in all undergraduate courses in an effective way.
2. There will be formal and informal systems in place to encourage and support instructors carrying out goal #1.

#### SEI subgoals—specifics needed to achieve the overall goals

1. Learning goals for all courses and programs will be created. These goals will clearly articulate what students should be able to do upon successful course completion, and the goals across courses will be well aligned.
2. Course designs and materials that target the learning goals will be created, guided by research on learning and student thinking in the discipline. Assessment tools that measure learning of these goals will be developed and used by faculty to guide improvement of course design and materials.
3. There will be mechanisms in place to ensure that A) all these materials are saved and disseminated, B) their subsequent use is effective, and C) they save faculty time.
4. Technology will be utilized effectively to enhance learning and allow optimal use of faculty time and other resources.
5. There will be incentive and reward systems that support the attainment of the goals.
6. There will be development and support programs which allow faculty members to successfully achieve Overall Goal #1 with a minimum of time and effort.

#### Some ubcsei Accomplishments: (many more at [cwsei.ubc.ca](http://cwsei.ubc.ca))

1. 16 major courses in process of transformation and evaluation. (thousands of students already impacted)  
New pedagogical approaches & technology. Lots of data on student learning, attitudes, experience.

2. Detailed learning goals/objectives for numerous courses.

*# 1 and 2 revealed some good current practices and revealed many opportunities for improvement (being pursued).*

- *Major misconceptions about student learning, some dismal aspects to student experience.*
- *Holes and duplication in instruction and assessment.*
- *Opportunities to use instructor and TA time better (more effective, more rewarding for students & faculty)*