The CU Science Education Initiative: Examining the Model and its Impact

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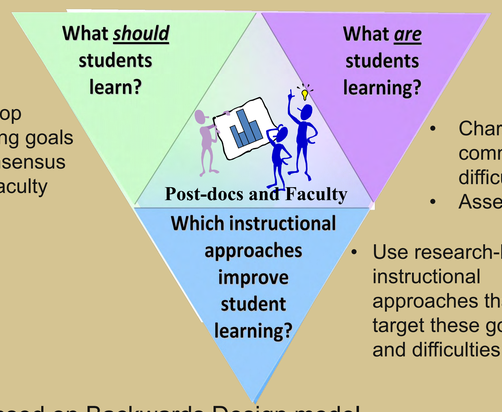
The Science Education Initiative: An experiment in Course, Faculty & Institutional Change

- 8-year, $5M university-funded program
- Included 7 departments
- Experiment to test a model of change in STEM education: Is it possible to scale-up the use of research-based techniques at a university so that they become the norm?
- Sister program at University of British Columbia (http://cwsei.ubc.ca)

Features of the SEI Model of Change

- Focus on department as unit of change[1,2]
- Competitive grant program with departmentally-submitted proposals
- Bulk of funding used to hire postdoctoral Science Teaching Fellows (STFs) to oversee course transformation
- STFs have PhD in discipline, an interest in education, and work at departmental level

Model of Course Transformation



- Develop learning goals in consensus with faculty
- Characterize common student difficulties
- Assess reforms
- Use research-based instructional approaches that target these goals and difficulties

- Based on Backwards Design model
- Ideally, starting with large introductory courses
- First, develop course learning goals
- Use goals, & research on student learning, to drive reforms

For more information, publications, videos and course resources:

http://colorado.edu/sei

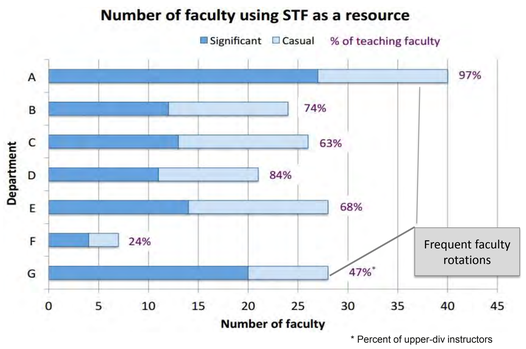
And look for upcoming papers on outcomes of the SEI

References

1. Wieman et al, "Transforming science education at large research universities," Change, 2010.
2. Chasteen et al., "A thoughtful approach to instruction," J. College Science Teaching, 40(4), 2011.
3. Hora and Hunter, "Exploring the dynamics of organizational learning," WCER working paper, 2013.
4. Chasteen and Perkins, "Change from within," Book chapter, CIRCLE STEM conference (in press)
5. PRST-PER Upper-Division collection, in progress
6. Overall impact of the Science Education Initiative; paper in progress

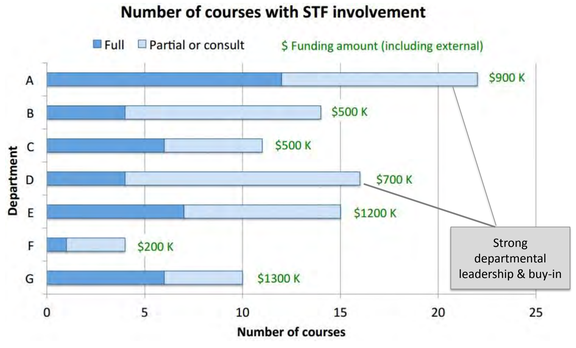
The impact: What happened?

Faculty impact



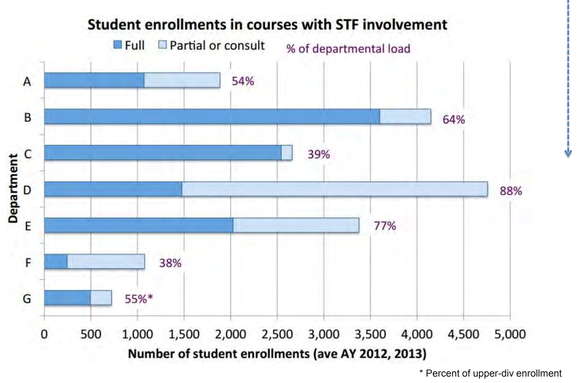
- **135 faculty have modified their teaching** (~50% of faculty); 93 added clickers, and 93 added other forms of interactive engagement
- Departments with **frequent faculty rotations** face sustainability issues, but impact more faculty
- In Physics, 80% of faculty use materials

Course Impact



- **Cost ~ $145K per course**
- **Physics focused on upper-division**; all but one core upper-division majors course remains untouched
- In Physics; **most commonly used** are clickers, homework, tutorials and learning goals; JiTT questions and exams are least used.

Student impact

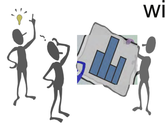


- **Average of ~20,000 students/year**
- In Physics, **92% of majors service load** in impacted courses (from SEI and prior effort)
- *Note: Not all SEI-affected courses maintain those changes*
- **Demonstrated student learning improvements** in Physics and Biology
- **Assessment tools** available for 51 courses

Structural components: What works?

The target of change: Course & Faculty Development

- **Introductory courses** are particularly tricky to transform
- **Consensus learning goals are difficult**, and hard to get traction with faculty
- **A course development model** is sometimes subsumed by a faculty development model due to lack of traction
- Faculty typically take **~2 years** to "change"
- **Student outcome data is not typically a compelling factor** for faculty to change; student engagement often is.



The agents of change: Postdoctoral STFs

- **Provide important resource** of time (research, coaching, and institutional memory[3]; ie., archiving)
- **STF training & community is critical**
- **Selection of the STF** is important; respectful, timely, solicitous, scholarly
- **Publication rate** varies widely; motivations vary by STF and department
- **Who do they work for**? Requires clear establishment of STF role as departmental staff, within departmental structure, but funded by SEI.

The purveyors of change: Departments & Administration

- **Lack of departmental ownership** of courses and course goals is a major challenge to self-sustaining course reform
- **Accountability and commitment** to change are problematic; "we can't tell our faculty how to teach."
- **Lack of institutional incentives for teaching** remains a dominant barrier.
- **Selection of "friendly" department chairs** affects departmental success
- **Selection of "friendly" teaching faculty** is important for sustainability of a course

Lessons learned

Departmental focus with STF support led to substantial and long-lasting change

- **Degree of success depends** strongly on departmental culture & organizational structure (e.g., faculty course ownership or rotation, teaching approach, interests of departmental chair).
- **Money helps.** At UBC, twice the funding per department allowed for greater SEI Central and departmental staff time, as well as faculty incentives.
- **Beginning with large-enrollment introductory courses and development of learning goals may be ill-advised**
- **Targeting early small, impactful and motivating interventions** likely generates more momentum, providing catalyst for change.
- **Oversight from SEI administration** is important for providing:
  - Clear expectations and *oversight* of STFs and departments
  - Formal, sustained STF training
  - Community-building among sizeable STF cohort
  - Proposal process with required deliverables and commitments (e.g., specific courses and teaching assignments).
  - Departmental accountability (e.g., real consequences for lack of follow-through in terms of funding & higher administration)