Department-based Science Education Specialists as agents of change in university education

Kathy Perkins,[1] Sarah Gilbert,[2] and Carl Wieman[1,2]

[1]Science Education Initiative and Dept. of Physics, University of Colorado, Boulder, Colorado, USA; [2]Carl Wieman Science Education Initiative, University of British Columbia, Vancouver, BC, Canada

Facilitate faculty communication and consensus building

- **Sharing of teaching ideas and resources among faculty**
- **Development of consensus learning goals**
- **Development of assessment measures (e.g. pre/post conceptual content surveys, surveys of students beliefs, etc.)**
- **Curriculum design and structures (e.g. development of tutorials for recitation, incorporation of learning assistants, use of clickers, etc.)**

Examples of Change

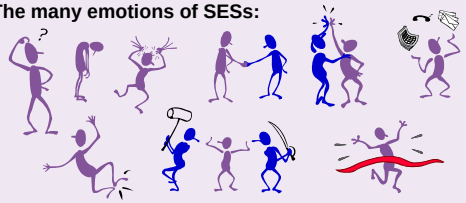
- Extensive use of "faculty working groups"
  - A group of faculty with interest in a particular course meet to define learning goals, share resources, input into assessment measures, etc.
  - Typically meet biweekly or monthly. Some summertime intensive meetings (2 days).
- Movement of content out of an over-crowded CU Chem 1 into Chem 2
- UBC Computer Science learning goals for 5 courses. CU MCD-Biology is developing and aligning learning goals for entire core curriculum.
- Widespread usage of pre/post tests and end-of-term surveys in courses throughout participating departments.
  - CU: 14 courses with new pre-post conceptual content surveys (+ 5 courses using pre-post prior to SEI)
  - 5 CU and 5 UBC depts using surveys of student beliefs about discipline and learning
- Some faculty posting explicit learning goals to students.
- UBC and CU assessments of usefulness of learning goals for students and faculty.

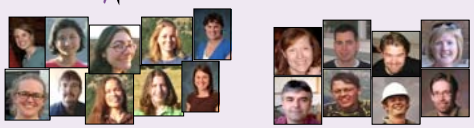
Science Education Specialists (SESs) *Agents of Change*

An SES:

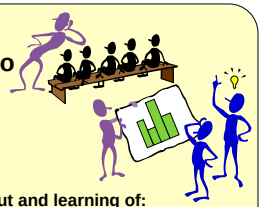
- **Is expert in particular science discipline (usually recent PhD)**
- **Hired by science department**
- **Given crash course in science education fundamentals (by SEI central)**
- **Has considerable ongoing interactions with and professional development through SEI central & community of SESs**
- **Works <u>with</u> faculty to develop learning goals, measure learning, change assessment & instruction…**

The many emotions of SESs:





Collect, distill, and communicate data to support and guide faculty efforts



- **Probe student thinking about and learning of:**
  - Content – specifically faculty-identified learning goals.
  - Beliefs about the discipline and learning in the discipline.
  - Usefulness of various course structures for learning, study behavior, enjoyment of various aspects of course, etc.
- **Methodologies used:**
  - Student interviews and focus groups
  - Classroom or recitation observations
  - Analysis of clicker questions, group work, homework, and exam responses
  - Conceptual assessment pre/post surveys
  - In-class and online belief/student feedback surveys

Examples of Change

- Introduction of "optional co-seminar course" in CU MCD-Biology due to evidence of improved performance of groups doing recitation-type activity.
- Introduction of many more visualizations and more connections to the real-world in CU's general chemistry due to poor performance on content questions / CLASS survey – result = improvement in performance
- Introduction of homework (CU anatomy, physiology, intro geoscience) in several courses, in response to student feedback on need for homework.

Barriers

Department:

- An unsupportive or inactive department chair
- SESs not integrated into department operation
- Departmental culture that …
  - prioritizes research and/or graduate education over undergraduate education
  - views education research as less scholarly
  - expects full academic freedom in teaching
- Lack of reward structure for faculty efforts on education
- University credit-hour limitations for majors
- Lack of teaching plan – last-minute teaching assignments

Faculty:

- Other time demands
- Getting faculty to understand the underlying pedagogy
- When views about teaching and learning are strong and inconsistent with SEI goals
- Low opinion of students

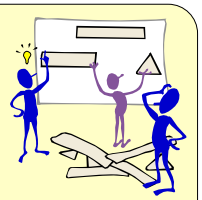
Course-specific:

- Multi-section courses (5 sections / 5 faculty) (or multiple faculty on same course – can also be facilitating).
- Non-standardized curriculum
- Barriers to content adjustment/enhancement
- Students who dislike new teaching approaches; poor FCQs

SES job:

- Multi-tasking aspects of SES job / time disruption of meetings
- Lack of good publication venues
- Difficulty in doing research – e.g. inability to control variables.

Develop curricular materials and teaching approaches in collaboration with faculty



- **New curricular material development. Three approaches – best one depends on context and faculty:**
  - Primary development by SES with faculty input/feedback
  - Co-development by SES and faculty
  - Primary development by faculty with SES input/feedback
- **Facilitating new course structures or teaching approaches (e.g. restructuring recitations, introducing clickers, adding in-class tutorials, using homework, ...)**

Examples of Change

- Tutorial activities created for several different courses (e.g. general chemistry 1&2, upper-division physics, environmental geochemistry, etc.)
- New collections of clicker questions in numerous courses
- Use of PeerWise[1] online collaborative multiple choice question repository (students write/take/rate questions) in UBC Computer Science Dept.
- Calibrated Peer Review[2] introduced in CU Integrative Physiology
- White boarding activities introduced in upper-division physics.
- Introduction of learning assistants (CU LA program) in CU Chemistry and Biology recitations

[1]http://peerwise.cs.auckland.ac.nz/ [2] http://cpr.molsci.ucla.edu/

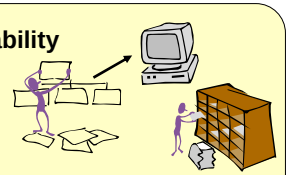
Serve as a local resource for faculty

- **Multiple pathways for faculty interactions:**
  - Formal partnering of SES with faculty for course development.
  - SES facilitation of faculty working group
  - Departmental faculty brown bags or workshops on education-related topics
  - SESs give departmental colloquium/seminar
  - Informal interactions:
    Faculty drop by office
    Email exchanges
    Hallway/colloquium conversations
- **SESs are resources for:**
  - General info on education research findings (e.g. how people learn)
  - Student thinking / student difficulties in the discipline
  - Implementation of new approaches (what makes a good learning goal, a good clicker question)

Examples of Change

- Large number of faculty formal and informal interactions with SESs
- Some faculty experimenting with research-based teaching practices with only minimal support from SESs (examples in CU's IPHY or MCDB and UBC's EOS and CS depts.)
- Number one request of faculty responding to survey on SEI efforts:
  'When can I partner with an SES on my course?'

Facilitate sustainability by archiving and disseminating



- **Compile/Organize resources:**
  - Learning goals, lecture notes, homeworks, assessments, …
  - Notes on student difficulties/thinking
  - Results of assessments of learning and surveys
- **Annotate resources with notes on student thinking and important implementation details**
- **Establish supporting structures**
- **Disseminate materials:**
  - To their departmental faculty directly
  - To department and broader community via UBC CWSEI web-based archive
- **Publish in discipline-based education journals**

Examples of Change

- On-going development of SEI Archive software development at UBC
- Both physical and electronic binders of materials in CU integrative physiology. Compilation and organization of faculty collections of homeworks in upper-division physics. Compilation of CU intro geology materials contributed from numerous faculty and redistribution.
- Develop and implemented TA training program in CU chemistry and UBC EOS.

Facilitating Factors

University or cross-departmental structures:

- Support at highest administrative levels
- Synergistic education-related efforts, e.g.
  - CU learning assistant program
  - Discipline-based education research group
  - Ties with school of education
- Multi-departmental effort – community of SESs

Department:

- Supportive Chair – values SEI project & raises its profile
- Broad departmental support
- Senior & junior faculty leaders/promoters for project
- Prior education reforms in department (e.g. tutorials in physics)
- SESs viewed as member of the faculty
  - Attends faculty meeting, report on SEI
  - Attends colloquium
  - Good visibility – central office
- Rewards for teaching
- Newly-formed department in need of new curriculum
- Classroom space for tutorial-style group work

Faculty:

- Faculty who are dissatisfied with student learning
- SES talking to faculty early and often – establishing a good working relationship

Course:

- Standard accepted curriculum
- Multiple faculty on same course – can also be barrier.
- Recitation section for implementing active learning
- Availability of TAs

SES job:

- Good interpersonal and conflict resolution skills
- Presenting results of research to faculty