CU’s Dept of Geological Sciences – Science Education Initiative Project (GEOL-SEI): A five-year plan to introduce and support an evidence-based and scientific approach to teaching

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Science Education Initiative
The GEOL-SEI is a 5-year project.

Goals:
- Improve undergraduate geoscience education
- Change the basic approach to teaching and learning
- Adapt already demonstrated evidence-based productive teaching approaches
- Develop scientific approach to teaching through geoscience education research

Resources:
- ~$1 million
- Administrative support
- Collaborators
On campus collaborators include other Dept-SEI projects and the SEI Central Staff.

- Chemistry & Biochemistry
- Geological Sciences
- Integrative Physiology
- Molecular, Cellular, and Developmental Biology
- Physics

Central Staff
The GEOL-SEI operates with the understanding that the traditional approach to teaching is not optimal for deep learning (Hake, 1998).

R. Hake, “…A six-thousand-student survey…” AJP 66, 64-74 (‘98).
GEOL-SEI promotes and works with faculty to develop student-centered and interactive approaches to teaching and learning in their courses.

Teacher’s knowledge and experience

Transmissionist Approach

Students’ PRIOR knowledge and experience

Constructivist Approach

Students’ NEW knowledge and experience
The GEOL-SEI uses a 3-step iterative process with instructors to transform existing and develop new courses.

1. DEFINE LEARNING GOALS
2. CREATE VALID ASSESSMENTS
3. DESIGN & IMPLEMENT EFFECTIVE APPROACHES
4. USE TECHNOLOGY
5. ARCHIVE MATERIALS
6. ASSESS PROGRESS
The GEOL department began transforming their geoscience teaching in lower-division courses first.

<table>
<thead>
<tr>
<th>Time Frame</th>
<th>Courses Taught by Geology Faculty</th>
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<tbody>
<tr>
<td>Fall 2006-present (inc. Springs)</td>
<td>GEOL 1010: Physical Geology</td>
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<td>Fall 2006-present (inc. Springs)</td>
<td>GEOL 1020: Historical Geology</td>
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<tr>
<td>Fall 2007-present (inc. Springs)</td>
<td>GEOL 1030: Intro to Geology Lab I</td>
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<tr>
<td>Fall 2007, 2008, 2009</td>
<td>GEOL 2100: Environmental Geology</td>
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<td>Fall 2007</td>
<td>ENVS 1000: Intro to Environmental St</td>
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<td>Fall 2008 &amp; 2009</td>
<td>GEOL 3010: Intro to Mineralogy</td>
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<tr>
<td>Fall 2008 &amp; 2009</td>
<td>GEOL 3120: Structural Geology</td>
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<tr>
<td>Spring 2008 &amp; 2009</td>
<td>GEOL 3070: Intro to Oceanography</td>
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<tr>
<td>Spring 2008 &amp; 2009</td>
<td>GEOL 3430: Sedimentology &amp; Stratigraphy</td>
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<tr>
<td>Spring 2009</td>
<td>GEOL 3520: Global Climate Change</td>
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<tr>
<td>Fall 2009</td>
<td>GEOL 3410: Paleobiology</td>
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To transform courses, GEOL-SEI uses and contributes to a growing body of STEM education research to inform best teaching practices at the undergraduate level.

- Research in cognitive science, educational psychology labs
- Research on brain function and development
- Research in K-12 classrooms and university classrooms
Types of assessments developed and used include:
- Challenging homework assignments
- Exams that promote sense-making over only answer-making
- Pre/post concept inventory surveys
- Pre/post attitudinal surveys

Class discussion of student ideas
Conversion of “cookbook” style lab work to “innovative” lab work
Undergraduate peer facilitators
GEOL-SEI and faculty collaborations have resulted in gradual and positive transformations in the basic approach to teaching.

- ~66% faculty defined learning goals
- ~55% faculty changed their teaching practices to be more aligned with what research shows to be effective
  - E.g. assign regular HW assignments, facilitate in-class group activities, lead in-class discussion of conceptual questions (with or without clickers)
- ~38% faculty ask conceptual questions in class
- ~34% faculty use clickers to engage ALL students
- ~24% faculty use in-class group activities
- 10 undergraduate learning assistants were formally trained and assisted with teaching courses and labs
- 11 undergraduate courses have been impacted, which equates to ~10,960 students (between Fall 2006 and the present)
In addition to course and curriculum development, the GEOL-SEI also supports faculty and students by initiating and running other geoscience education-related activities:

- **Monthly Geoscience Education faculty brown bag series**
- **GEOL graduate TA pedagogical training**
- **GEOL undergraduate Learning Assistant program**
- **GEOL Tutoring & Study program**
- **Simulation development**
- **iClicker faculty training and support**
- **Monthly Geoscience Education faculty brown bag series**
Efforts to integrate a scientific approach to teaching and learning has resulted in GEOL-SEI scholarship in Geoscience Education Research:

- Duncan and Arthurs, (submitted), “How do students respond to simple ways of improving student attitudes about science?” Astronomy Education Review
- Several other manuscripts are currently in preparation.
A model of sustainability might include one or more of the following possibilities.

- **Educ’l Progs.**
- **C&C D&T**
- **DBER Rep’n**
- **GER**

**Current Faculty Member** – takes on one or more of these programs for personal interest, service project, course load reduction, etc.

**New Staff / Consultant Position** – provides faculty and students with Pedagogical & Teaching Support (PTS)

**New Instructor Position** – teach; coordinates educational programs; represents Dept in DBER community; GER research is optional / on the side

**New Faculty Position** – scholarly research program in geoscience education is required; mentor and support students and post docs* to do geoscience education research; teach

* SEI Central provides mentoring and training to STFs in science education research. This support will end when the SEI Project ends. Current STFs believe that future post docs should have similar support, ideally in the form of a geosced faculty advisor.
Thank you!

Any questions?