Science Teaching Fellows (STFs, with Ph.D.s in the geosciences and pedagogical training) help the faculty to:
- define learning goals,
- align lectures and assessments with those goals,
- develop and implement new materials to improve student learning,
- assess student learning and thinking.

**Introductory (1000-level) courses**

Generate ~8000 student credit hours per year and involve ~40% of the faculty & instructors in any one year.

**Challenges**

- No separate tracks for majors and non-majors, STEM and non-STEM students. This leads to wide differences in students’ motivation, expectations, studying styles, and background.
- Departmental culture lets each faculty member determine the content of their individual section, which allows faculty to include varying degrees of material related to their research expertise. The Department sees this as the value added in a research university.

- **Introduction to Geology (GEOL 1010)** & **Introduction to Earth History (GEOL 1020)**
  - Faculty working group defined course-level learning goals that were adopted by all instructors.
  - Unit- and lecture-level learning goals defined by “2/3s of individual 1010 instructors and all 1020 instructors.
  - All sections now utilize clicker technology or other methods to encourage student thinking, peer learning, and student-teacher interactions.
  - All sections now utilize homework as formative assessments, often on a weekly basis.
  - Many instructors now utilize homework* as methods to encourage student thinking, peer learning, and student-teacher interactions.

- **Introduction to Geology Lab (GEOL 1030)** & **Introduction to Earth History Lab (GEOL 1040)**
  - Course-level and lab-level learning goals defined.
  - New lab manual based on those goals to debut in Fall, 2010.
  - TA preparation improved and now includes pedagogical training.
  - Lab manual and development of recitations for 1010 to be revisited in 2010-2011.

- **Introduction to Geology Lab (GEOL 1030, stand-alone lab course)**
  - Surveys to evaluate incoming students’ attitudes, opinions, and prior knowledge related to geology in general and specific geologic concepts.
  - Course-level and lab-level learning goals defined.
  - New lab manual based on those goals to debut in Fall, 2010.
  - TA preparation improved and now includes pedagogical training.
  - Concept inventory to assess learning gains under development in association with new lab manual.

- **Global Change: An Earth Science Perspective (GEOL 1060)**
  - Course-level and module-level learning goals defined.
  - Clicker technology introduced to encourage student thinking and student-teacher interactions.
  - Homework implementation.
  - Sustainability an issue – initial collaborating faculty member left CU and current faculty instructor seems less willing to continue “deep” transformation efforts; class maybe dropped from curriculum.

- **Environmental Geology (GEOL 2100)**
  - Course-level and module-level learning goals defined.
  - Integrated interactive engagement pedagogy; designed, implemented, and evaluated in-class group activities; incorporated undergraduate Learning Assistants to promote student thinking and peer learning; and utilized clicker questions to facilitate peer learning and class discussion.
  - Restructured assessments such as exams and aligned them with learning goals.
  - Developed and used concept surveys to assess students’ prior knowledge and learning gains.

**Other Accomplishments**

- Development and implementation of GEOL TI training.
- Establishment of a Geology Tutoring & Study room.
- Facilitating use of LAs in GEOL classes.
- Developing interactive simulations with the PhET project.
- Development of an assessment survey for ENVS 1000.
- Development of a Geology Tutoring & Study room.
- Development of an assessment survey for ENVS 1000.
- NSF-funded project on students’ affective domain.

- **Course Transformations (*** denotes work still in progress)**

- **Upper division non-major courses**
  - **Global Change: The Geologic Record (GEOL 1040)**
    - STF is currently teaching the class and has defined learning goals.
    - Is transforming course from dominantly lecture-based passive learning to dominantly active-learning through interactive engagement pedagogy and in-class group activities.
    - Development of a concept inventory has begun.
  - **Introduction to Oceanography (GEOL 3070)**
    - Identified key concepts that are foundations of the course and defined learning goals.
    - Integrated clicker questions to facilitate student thinking, peer interaction, and discussion.
    - Developed a validated concept survey to assess students’ prior knowledge & learning gains.
  - **Earth Resources & The Environment (Geol 3500)**
    - Without STF help, instructor used knowledge gained in 1010 transformations to write learning goals and align lectures and activities to those goals.
  - **Critical Thinking In The Earth Sciences (GEOL 4500)**
    - Partnered with junior faculty instructor to develop and implement interactive simulations with PhET.
    - Developed new assessment and teaching strategies to improve CT concepts and skill development.

- **Upper division major – track courses**

  - **Introduction to Mineralogy (GEOL 3010)** & **Structural Geology (GEOL 3120)**
    - Identified student learning difficulties, improved the conceptual focus.
    - Developed in defining learning goals for labs, aligning lab activities with those goals & lectures, developed and introduced “warm up” activities to focus student thinking and interest.
  - **Paleobiology (GEOL 3410)**
    - Development of learning goals, identifying student learning difficulties, and improving laboratory activities.
  - **Sedimentology & Stratigraphy (GEOL 3430)**
    - Focused learning goals, advised faculty instructor on reducing lecture content so as to increase learning.
    - Indentify student misconceptions and learning difficulties and helped redesign lectures and homework to address these issues.
  - **Fluid Earth (GEOL 3820)**
    - Redefining learning goals, restructuring course format (lecture/discussion ratio) and assessments.
    - Integrating pedagogical project into the implementation of in-class IBL demonstrations.
    - Developing concept surveys to assess students’ prior knowledge and learning gains.

**Highlights**

- Participation in the SEI since Fall, 2006
- 19 of 30 faculty (~63%) have voluntarily undertaken collaborative efforts with the SEI.
- 5 of 6 1000 and 2000-level courses, 5 of 8 major-track 3000-level courses, and 4 of 8 general education upper division courses have received some level of transformation.
- Unwillingness of individual faculty members (all senior professors) to consider reforms will prevent any efforts in 6 of the 8 untransformed courses in the above list.
- Transformation of large enrollment courses is of moderate success at best, due to the Department’s use of multiple faculty instructors in these courses, with each instructor preparing independent lectures and exams, and each with different pedagogical needs and.
- Tangible rewards (aside from words of praise and self-satisfaction) for the significant effort needed to develop and implement changes is developing as a significant barrier to continued teaching improvements.
- Nonetheless, SEI concepts are now an integral part of the teaching mission of the department as they are:
  - routinely considered in departmental curriculum deliberations.
  - participation in course transformation is acknowledged in annual merit evaluations and tenure deliberations.
- Sustainability lies in:
  - Archiving of all newly generated course materials.
  - Emergence of a cadre of ~12 faculty members, including assistant professors or recently tenured associate professors, with a strong commitment to SEI concepts.
  - Including course alignment, curriculum goals, and other SEI-related concepts in upcoming PRP deliberations.

**Other Thoughts**

- In hindsight, at the start of an initiative like the SEI,
  - Geological Sciences faculty need more convincing of the need and value of transformation.
- Geological Sciences faculty need more training as to what transformation really requires of them.
- Then detailed faculty deliberation, planning, and consensus building could clearly define what goals the faculty are really willing to undertake.
- An independent, multi-institutional (including CU-Geological Sciences), NSF-funded project on students’ affective domain and its affect on learning in introductory geology, suggests that failure to address motivation and learning strategies can offset a significant fraction of the gains expected when transforming the cognitive aspects of the learning process.
- That is, addressing what the students do and how they think is probably a prerequisite to changes in how students are taught.

**Summary of Transformation Accomplishments**

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