Assessment Activity Report Due April 21, 2017
to the Office of Academic Planning, ADM 450

Closing the Loop template

Department: Earth & Climate Sciences

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College: Science & Engineering

Our new B.S. and revised B.A. programs in Earth Sciences are now two years old. Relatively few students have completed the program in its entirety; most graduates of these two programs switched from one of our previous programs: the B.S. in Geology, the B.S. in Atmospheric and Oceanic Sciences, or the previous version of the B.A. in Earth Sciences. We felt that the aspect of our new programs that needed the most urgent attention was one of the five core courses, ERTH 205, required of all students in both programs, rather than any particular subset of our program SLOs. Hence, our assessment and evaluation efforts this year is more course-focused than program SLO-focused.

A. Please list your program learning goals.

   See Appendix I.

B. What assessment finding(s) is the department addressing?

   1. As taught, ERTH 205 required more prior knowledge of disciplinary content and techniques than some students had and that the course prerequisites required.
   2. The course required too many assignments and didn’t allow enough time for students to complete them.
   3. The course emphasized geology concepts and techniques at the expense of techniques in other Earth sciences disciplines (meteorology, oceanography, climate, and hydrology).
   4. The class size was too big and the class suffered from disorganization and poor communication between the two co-instructors.
   5. The portions of the course conducted in the field were instructive and enjoyable.

C. What was the process through which faculty considered a response to those findings? A department meeting? A special meeting about assessment? An end of the semester or academic year retreat? A department assessment or curriculum committee?
Background

Our assessment and evaluation focused on ERTH 205 ("Techniques in Earth Sciences", 2 units lab; prerequisite: an introductory Earth sciences course). ERTH 205 is one of five core courses required by our new B.S. program and revised B.A. program in Earth Sciences and was taught for the first time in Fall 2016, the second year of implementation of both degree programs. (All of the other four required core courses had been taught in the first year of program implementation the previous year.)

In June 2016, funded by a Teagle grant, we staged a half-day workshop attended by 9 of our 12 tenured and tenure track faculty members. We organized the participants into three disciplinary subgroups corresponding to the three emphases of our one-year-old B.S. in Earth Sciences program (geology, hydrology, and ocean, weather, and climate) and asked each subgroup to identify a small number of overarching student learning goals and ancillary goals for each of the five required core courses in the Earth Sciences B.S. program, including ERTH 205, keeping in mind the overall program student learning outcomes. We then tried to organize and summarize the draft course student learning goals (see Appendix II).

In August 2017, again funded by our Teagle grant, we conducted a 3.5 day workshop at which, among other things, we tried to help the core course instructors develop concise course learning objectives (see Appendix III), a content outline, a pedagogical strategy, ideas for assignments, and a syllabus, guided by the brainstormed course SLOs developed by the tenured/tenure track faculty earlier that summer. Participants included both of the lecturers whom we hired to co-teach ERTH 205.

Both of these ERTH 205 co-instructors had earned M.S. degrees in Geology. One of them had just graduated from our M.S. program in Geosciences and was a first-time instructor. The other had earned a B.S. in Geology at SF State (before we replaced that program with the Earth Sciences B.S.) and had started in our M.S. program in Geosciences before transferring to another university to finish her graduate degree. While enrolled in our B.S. program in Geology, she had completed GEOL 120 ("Techniques in Geology", 2 units lab), a now-defunct version of ERTH 205 that served geology students (but not oceanography or meteorology or hydrology students). She had three semesters of teaching experience as a lecturer in our Department (several GE courses and one upper division geology majors’ course).

Of the five required core courses, ERTH 205 is one of the two most challenging to teach (our GWAR course is the other) because it comprises two lab periods with no formal lecture, has a heavy field emphasis, and is perhaps the most sensitive to differences among the diverse Earth sciences disciplines that the Earth Sciences degree programs aim to integrate. Among the core courses, it is also one of the most common prerequisites to other, discipline-specific courses, so more members of the Department faculty have a stake in what is taught in ERTH 205.

Because we had not offered ERTH 205 in the first year of implementation of the new B.S. and revised B.A. Earth Sciences program (2015-16), demand had accumulated by Fall semester 2016, when we offered it for the first time. This had two consequences. First, thirty students enrolled, whereas we consider 24 students
to be a reasonable maximum for a lab class such as ERTH 205, and second, the students possessed a wider range of prior academic experience than we envisioned when we designed the B.S. and B.A. programs. Several sophomores had little or no Earth science background, several seniors were completing the last year of the lame duck B.S. program in Geology, and other students had levels of preparation between these two extremes.

**Assessment (Data Gathering) Strategy**

Our assessment data comprised (1) student evaluations of each of the two ERTH 205 co-instructors and the course itself, using SF State’s standard, online student evaluation of teaching effectiveness (SETE) survey; (2) anecdotes about the course that one of the instructors and several students told us; and (3) assignments and the syllabus (which included course SLOs) that the instructors posted on iLearn. (One of the instructors assembled a sample of graded student work that students had not claimed and made it available for us to examine, but we haven’t looked at those materials independently.)

**Evaluation Strategy**

In late March 2017, we staged our annual faculty retreat and invited one of the ERTH 205 instructors to participate in an evaluation of ERTH 205. The instructor described the course and some of the problems that she and her co-instructor encountered, as well as some things she thought went well (see Appendix V). We made an attempt to align some course assignments with course learning objectives based on the instructor’s description of the assignments (see Appendix IV), though faculty members tended to prefer brainstorming freely about ways to address some of the problems about which they’d heard anecdotally from students and the instructor (Appendix IV).

The Department Chair (Dave Dempsey) subsequently analyzed the SETE survey results organizing them into categories (see Table 1). Based on these results and the discussions at the faculty retreat, he hired one of the two original lecturers to serve as the primary instructor for ERTH 205 in Fall 2017 and assigned a new faculty member, Dr. Piero Mazzini (an oceanographer), to contribute his expertise to teach about 20% of the course. In May 2017, Dr. Dempsey met with the two new co-instructors to continue evaluating and suggesting revisions to the course, including the course SLOs.

**Assessment and Evaluation Findings**

The department’s assessment and evaluation of ERTH 205 produced the following findings:

1. The course required more prior knowledge of disciplinary content and techniques than some students had.
2. The course required too many assignments and didn’t allow enough time for students to complete them.
3. The course emphasized concepts and techniques in geology at the expense of techniques in our other Earth sciences disciplines (meteorology, oceanography, climate, and hydrology).
4. The class had too many students and suffered from disorganization and lack of communication between the co-instructors.
5. The portions of the course conducted in the field were instructive and enjoyable.

Student anecdotes about the course were generally consistent with their comments on the SETE survey.

Both instructors noted that in small-group, in-class activities, students tended to spend a lot of time off-topic, which undermines comments by some students on the SETE survey that instructors didn’t allow enough time to complete assignments (item #2 above). However, a set of related take-away messages that emerged clearly from the SETE survey (Table I) was that assignments were too numerous (item #2 above), aimed at too high a level (item #1 above), needed more supporting background (Table 1), and needed more explicit instructions to complete (Table 1). The presence in the class of advanced students completing the legacy B.S. program in Geology probably reinforced a sense that the relatively inexperienced instructors might have gotten that students could handle a more advanced treatment of the material than many of them actually could.

Both instructors were trained in geology, were teaching a new course for the first time, had other, demanding teaching assignments, and were relatively inexperienced, so we were disappointed but not especially surprised that students in the hydrology and the ocean, weather, and climate emphases of the B.S. in Earth Sciences felt shortchanged (item #3 above). We hired these two lecturers in particular because we felt that their academic backgrounds were broader and more multidisciplinary than traditionally trained geologists have; we tried to emphasize the importance of serving all of our student constituencies; we offered a draft assignment or two in meteorology for them to adapt; we encouraged to choose subject matter that would serve multiple disciplines, not just one; and we warned them about the likelihood that in the face of the unrelenting pressure to create new assignments throughout the semester, they would fall back on what they knew best (geology) and especially a previous incarnation of the course that served only geologists (GEOL 120, “Introduction to Geologic Techniques”). Nonetheless, these measures didn’t translate into even-handed treatment to all disciplines.

Reflecting their training in geology, both instructors were comfortable running field trips. With the exception of a safety near-mishap and a minor complaint or two about paying for provisions, the students spoke and wrote favorably about the several field trips that the instructors led (item #5 above). Field experience is an important part of preparation in the Earth sciences, so this was good news.

D. What changes have you made or are you seeking to make in order to address the findings?
• Rather than hire two co-equal lecturers with similar disciplinary training, we are rehiring one of the two original instructors to serve as the primary instructor for the second offering of the course, in Fall 2017. (This instructor drew the more favorable student evaluations of the two co-instructors and has fewer personal logistical obstacles to teaching it again next fall.) She will teach about 80% of the course. (This should help address item #4 in the previous section, above.)
• We have assigned Dr. Piero Mazzini, a newly hired oceanographer with strong background in field observational techniques and quantitative methods, to take responsibility for teaching about 20% of the course, focusing on oceanographic and atmospheric techniques. He will receive financial support from our Teagle grant in summer 2017 to develop his part of the course. (This should help address item #3 in the previous section, above.)
• We suggested ways to reduce the number of assignments and the extent of prior knowledge required of students, thereby giving instructors time to provide more instructional background and for students to complete the assignments, all while keeping the course and program SLOs in sight. (This should help address items #1, #2, and #4 in the previous section, above.)
• We suggested revisions to the course SLOs to clarify them, make some of them less specific to certain disciplines, and deemphasize one or two SLOs to help make the course more manageable and address the program SLOs more consistently for all students in the course.

E. What assessment activities do you plan to undertake next academic year? Is there a particular program learning goal that you would like to assess? Are there other assessment findings that you’d like to address? In light of your assessment work, changes in the field, or other influences, do you want to take the opportunity to revise the program goals next year? Will you move on to assess a different learning goal?

The Department’s Curriculum Committee will meet with the ERTH 205 instructors after the semester to review assignments, SETE survey results, and the instructors’ accounts of the strengths and weaknesses of the course, all in light of the program and course SLOs, and to recommend changes as needed. We will need to do the same thing for ERTH 400 (“Earth Systems II”, 2 units lecture, 1 unit lab), another required core course, which a newly hired lecturer will teach in Fall 2017.

We haven’t yet selected particular SLOs to address in 2017-18. However, we suspect that our program might not address the two SLOs under “Application to societal issues” (Appendix I) especially well, at least not for all students.

Our program SLOs are relatively aspirational and uncontroversial. However, they aren’t defined in ways that make quantifying or otherwise evaluating the extent of student progress toward achieving them straightforward, so we might want to consider how we might make them more practically useful for evaluating our program.

Table 1: Categorization of Students Comments about ERTH 205 from SETE Survey (Fall 2016)
<table>
<thead>
<tr>
<th>Comment Categories</th>
<th># Comments in Each Category</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aspects of the course that were effective:</strong></td>
<td></td>
</tr>
<tr>
<td>Geology content and tools</td>
<td>xxxxxxx</td>
</tr>
<tr>
<td>Field trips/field activities</td>
<td>xxxxxxxxxxxxxxxx</td>
</tr>
<tr>
<td>Field report</td>
<td>x</td>
</tr>
<tr>
<td>Hands-on activities</td>
<td>x</td>
</tr>
<tr>
<td>Microsoft Excel</td>
<td>x</td>
</tr>
<tr>
<td><strong>Aspects of the course that could be improved:</strong></td>
<td></td>
</tr>
<tr>
<td>Pre-assess what students already know</td>
<td>xx</td>
</tr>
<tr>
<td>(very wide range of prior knowledge)</td>
<td></td>
</tr>
<tr>
<td>Provide broader Earth science perspective/exposure</td>
<td>xxxxxxx</td>
</tr>
<tr>
<td>More background/content/skill [esp. Excel] instruction</td>
<td>xxxxxxxxxxxxxxxxxxxxxxxx</td>
</tr>
<tr>
<td>before field/labs/assignments, and more explicit</td>
<td></td>
</tr>
<tr>
<td>assignment instructions</td>
<td></td>
</tr>
<tr>
<td>Reduce amount of material</td>
<td>xxxxxxxxxx</td>
</tr>
<tr>
<td>Reduce class size</td>
<td>xx</td>
</tr>
<tr>
<td><strong>Recommend Course or Not?</strong></td>
<td></td>
</tr>
<tr>
<td>No for meteorologists/oceanographers and/or yes for</td>
<td>xxxxxxx</td>
</tr>
<tr>
<td>geologists</td>
<td></td>
</tr>
<tr>
<td>No for students without prior field experience and/or</td>
<td>xxx</td>
</tr>
<tr>
<td>content knowledge (geology in particular)</td>
<td></td>
</tr>
<tr>
<td>Yes—engaging and worthwhile for any aspiring scientist</td>
<td></td>
</tr>
<tr>
<td>Only when better planned and organized, reduced</td>
<td>xxxxxxx</td>
</tr>
<tr>
<td>workload, etc.</td>
<td></td>
</tr>
<tr>
<td>Yes—chance to practice in the field what we learn in</td>
<td>xxxxxxx</td>
</tr>
<tr>
<td>class</td>
<td></td>
</tr>
</tbody>
</table>
Appendix I:
Student Learning Outcomes for B.S. in Earth Sciences

Graduates will be able to:

Scientific principles and methods
Apply the scientific method to solve problems in the Earth sciences, which includes making observations, asking scientific questions, forming and testing hypotheses, and analyzing and evaluating the results. In particular:
• collect, analyze, and interpret observations, and use field and laboratory equipment and data analysis software appropriate to their area of emphasis in the Earth sciences
• explain that all observations contain uncertainty and be able to quantify this uncertainty
• retrieve, use, and critically interpret the scientific literature
• create and interpret graphical representations of data
• create, manipulate, and interpret mathematical representations of Earth systems models

Process-level understanding
• demonstrate a qualitative understanding of the processes driving the major Earth systems, including the tectonic cycle, hydrologic cycle, carbon cycle, and Earth’s energy budget
• demonstrate a quantitative understanding of the processes driving the Earth systems in their area of emphasis
• demonstrate an understanding of the time and space scales of processes controlling changes in the major Earth systems

Application to societal issues
• use scientific principles to inform society and evaluate issues arising from environmental change, such as natural hazards, resource management, and climate change
• give an informed critique of the scientific issues underlying current policy discussions that relate to their emphasis area

Communication
• collaborate effectively
• effectively communicate scientific information in a variety of oral, visual, and written formats
Appendix II:
Initial Draft: Overarching and Ancillary Goals for ERTH 205
(Summary of faculty subdisciplinary brainstorming session, June 2016)

Geology Subgroup (John Caskey, Yadi Ibarra, Mary Leech)

Overarching Goals:
Apply basic scientific concepts to learn introductory map-reading skills, analytical skills, computer graphics, and report-writing.

Ancillary Goals:
1. Be able to collect basic Earth Science data in the field
   • use a Brunton compass to collect simple structural data
   • identify basic rock types
   • identify basic structures
2. Be able to write a clear, accurate report about field observations
   • relative dating principles
3. Be able to use maps and remote-sensing techniques to interpret spatial data
   • read and interpret contour maps and other types of maps
   • E.g., topographic and geologic maps
   • including using a scale (applies to any kind of map), legend (see geologic time units), etc.
   • Google Earth, satellite data
4. Be able to use software tools such as Excel, Matlab, and Adobe Illustrator
   • create a cross-sectional profile across a map and plot it up
   • start with more basic program (MATLAB, R, JMP?)
5. Be able to present results of a data analysis to others
   • incorporate photography into analysis and report
6. Explain how Earth Sciences affect society, including ethical considerations
7. Learn about educational and career opportunities
   • geotechnical careers?

Hydrology Subgroup (Jason Gurdak and Leonard Sklar)

Overarching Goals:
1. Students should be able to collect, communicate and apply data from the field, laboratory, and existing literature and models about the major earth systems

Ancillary Goals:
2. Collect data
   o Know what they're measuring and why (go to right place, at right time)
   o Show up with right equipment: note book, pen
   o Understand measuring device/method/system (units, etc.)
   o Neat, organized, careful documentation, back-up
   o QA/QC data entry
3. Write a report
   - Intro, methods, results, discussion, conclusion
   - Writing, revision, review
   - Make graphs, maps, visual display of information
   - Background literature: find sources, skim/read, cite in text and ref list
   - Neat professional presentation

4. Use software:
   - Data crunching: Excel
   - Data plotting: Excel/JMP
   - Mapping: illustrator
   - Writing: word

5. Work in teams
   - Sharing responsibility
   - Safety in the field

Organize projects around scientific process: design data collection, collect field data, bring back samples for lab analysis, plot data against published values, synthesize, plot/illustrate, write, revise.

Project design
- First project: give them predigested plan
- Second project: have them critique plan
- Last project: have them design plan

Ocean, Weather, and Climate Subgroup (Petra Dekens, Dave Dempsey, John Monteverdi, and Zan Stine)

**Overarching Goals:**
1. Students will be able to collect observations in the field, archived data, ...  
2. Students should be able to make and interpret graphical representations of data.
3. Students should be able to recognize, describe, and analyze spatial patterns in Earth sciences data.

**Ancillary Goals:**
4. Students should develop comfort with presenting results of calculation at the board. (Maybe move to a different, higher level course?)  
5. Students should be able to consistently handle convoluted unit conversions (using the factor label method)
Appendix III:
ERTH 205 Course Learning Objectives

(From ERTH 205 Syllabus, Fall 2016.
Developed as part of 3.5-day Earth Sciences program core course development workshop in August 2016, building on an initial brainstorming session in June 2016.)

The primary objective of this course is to prepare students for upper-division coursework in the Earth Sciences. Whereas most required courses focus on specific content, this course will focus on providing an Earth Science framework within which to place the content. The course also aims to provide an introduction to Earth Science methods for students who are not completing the major but who wish to strengthen their Earth Science background. Through this course students should gain confidence in their ability to use Earth Science tools and to communicate scientific information. All of the course content will be further developed in subsequent majors’ courses.

Specific objectives are for students to:

- be able to collect basic stratigraphic, petrologic and structural data in the field;
- be able to collect hydrologic and weather data in the field and from online sources;
- be able to collect coastal data (beach profile/wave size) and display in graphic form;
- be able to interpret scientific graphs, figures, topographic maps, and aerial photographs;
- be able to write clear, accurate reports about observations and interpretations;
- consider societal aspects of Earth Science, including ethics and career opportunities;
- learn how to locate and summarize published papers;
- gain practice working with a group to present results.
Appendix IV:
Alignment of Assignments with Course SLOs
(Based on instructor descriptions of assignments at faculty retreat in March 2017)

ERTH 205 SLOs and Corresponding Instructional Activities and Assignments

- **Be able to collect basic stratigraphic, petrologic and structural data in the field.**
  - cross-section assignment (Pt. Reyes), using data gathered in field along with a paper that instructors translated for the students;
  - locating sites on a map;
  - stratigraphic assignment;
  - terrace mapping

- **Be able to collect hydrologic and weather data in the field and from online sources.**
  - collect data in field using thermometers, sling psychrometers, and salinity meters; present it in Excel (which was hard for some students)
  - couldn’t gather stream velocity data

- **Be able to collect coastal data (beach profile/wave size) and display in graphic form.**
  - sediment sorting, rock ID, pace and compass activity (beach profile, wave height)
  - [Several suggestions offered by faculty brainstormers about what might be done in this area; investing in equipment for student research might be worthwhile]

- **Be able to interpret scientific graphs, figures, topographic maps, and aerial photographs.**
  - Google Earth provided access to aerial photos, etc.

- **Be able to write clear, accurate reports about observations and interpretations.**
  - Freshmen students couldn’t express ideas clearly, logically. Not all students turned in the first assignment and didn’t appreciate the impact of a zero on an assignment

- **Consider societal aspects of Earth Science, including ethics and career opportunities.**
  - No specific assignment targeting this, though some aspects did come out in individual presentations of final reports; talked about it frequently during field trips adventitiously

- **Learn how to locate and summarize published papers.**
  - Didn’t do a great job on this. Would like to create an assignment to do this. Maybe too much—they’ll have to do this in subsequent courses.

- **Practice working with a group to present results.**
  - Lots of practice at this. Included group processing, such as peer evaluation.
Appendix V:
Instructor’s Description of ERTH 205 (Fall 2016):
Strengths, Weaknesses, and Faculty Input
(Gathered at faculty retreat in March 2017)

ERTH 205 (Shirin Leclere)

• Beth and Shirin had some trouble creating some context for taking measurements using instruments. Need better-motivated contexts for taking measurements.
• Accessing (weather) data online worked well.
• Couldn’t have done the class without Russell and his knowledge of equipment.
• Final report showed cross section and thin section—clearly geology.
• Excel graphs of salinity and temperature.
• Couldn’t use tool that measures water flow speed because couldn’t get to good place with flowing water.
• Need to get students to buy in to learning about stuff across the curriculum.
• Students who knew a lot already often helped other, less advanced students.
• Co-teaching was a problem.
• Would be good to have an overarching question within which we can integrate knowledge and techniques across disciplines: set the stage to motive everything else we do in the class. Use Earth system ideas. Pose good questions that techniques would help address.
• Writing: Have two assignments addressed in stages with feedback.
• Need explicit instruction in graph creation conventions (not just Excel mechanics)
• Some programming experience would be good.
• Shouldn’t ever have students doing an analysis that doesn’t teach students something about the earth, so need to have a context for any technique taught.
• Would be helpful to have faculty offer suggestions about activities that achieve the ends they want served.
• Should ERTH 205 be the context for writing instruction? Yes.