Assessment Activity Report Due Nov 15th, 2016
to the Office of Academic Planning, ADM 450

Assessment Findings
Department: Earth & Climate Sciences
Department Contact: Dave Dempsey, Department Chair (dempsey@sfsu.edu)
College: College of Science and Engineering

Please list your program learning goals:

Student Learning Outcomes for B.S. in Earth Sciences

Graduates will be able to:

I. 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:
   1. 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
   2. explain that all observations contain uncertainty and be able to quantify this uncertainty
   3. retrieve, use, and critically interpret the scientific literature
   4. create and interpret graphical representations of data
   5. create, manipulate, and interpret mathematical representations of Earth systems models

II. Process-level understanding
   1. 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
   2. demonstrate a quantitative understanding of the processes driving the Earth systems in their area of emphasis
   3. demonstrate an understanding of the time and space scales of processes controlling changes in the major Earth systems

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

IV. Communication
   1. collaborate effectively
   2. effectively communicate scientific information in a variety of oral, visual, and written formats
Which program goal did you choose to assess this semester?

Refer to the SLOs listed above. (See response to the next question for context.)

- I.5
- either II.1 or II.2
- either III.1 or III.2
- IV.2

How was the assessment completed? What evidence did the faculty consider (e.g. written papers, presentations, portfolios)?

The 2015-16 academic year was the first year of implementation for our new Earth Sciences B.S. program and revised Earth Sciences B.A. program. The Earth Sciences B.S. replaced our Geology B.S. and Atmospheric and Oceanic Sciences B.S. Most of our spring and summer 2016 graduates completed one of the two legacy B.S. programs or the pre-revision B.A, but two students switched to the Earth Sciences B.S. and one switched to the revised Earth Sciences B.A. in time to graduate with one of these degrees. With an eye toward the future, we focused our program evaluation on those three students, although only part of their education reflected the experience that future students will get in the new or revised degree programs.

As the culminating experience for the new Earth Sciences B.S, students must complete a senior project, a B.S. Honors Thesis, or a 4-6 week summer field course, and students completing the revised Earth Sciences B.A. can opt to complete a senior project. All students must also complete ERTH 690 (“Capstone Presentation”, 1 unit), where they create a poster about their culminating experience and present it at an Earth & Climate Sciences Research Symposium, which we staged in 2016 for the first time, in the hallway of Thornton Hall one evening during finals week. (Our graduate students also presented posters at this event.) We invited underclassmen, graduate students, alumni, faculty members, emeritus faculty members, staff, and others (and provided food). We expect this to be an annual event.

As our inaugural program evaluation activity, we asked four of the attending (external) visitors to evaluate the posters presented by the three students graduating with the Earth Sciences B.S. or revised B.A. We designed a four-level Likert scale instrument (attached) and asked them to evaluate how well they thought each poster and presenter demonstrated that each student had met each of four program student learning outcomes (SLOs). (For two of the four SLOs, evaluators could choose between two SLOs based on relevance to the poster topic.)

The four evaluators comprised:
- An emeritus faculty member (a geologist)
- A recently hired Assistant Professor of Geology who will join the Department in January, 2017
- An alumna (in paleoceanography) of our M.S. program in Geosciences (class of 2014)
- An alumnus of our B.S. program in Atmospheric in Atmospheric and Oceanic Sciences (class of ~2004)
The topics of two of the three student posters were about atmospheric science and one was about geology. One student presented a poster based on his B.S. Honors Thesis; one B.S. student presented a preliminary study of the site in Michigan where he would complete a summer field course; and one presented a poster based on the senior project for his B.A. (These span all three types of project- or research-based culminating experiences from which B.S. students can choose; the senior project is also a culminating experience option for the B.A.)

What did you find? Is the learning goal being met?

Students in our legacy Geology B.S. program were required to complete either a B.S. Honors Thesis or a summer field course, while our legacy Atmospheric and Oceanic Sciences B.S. program required neither (though a thesis was a rarely selected elective). However, we did not ask students of either our legacy programs to create and present a poster about their experience (though B.S. Honors Thesis students presented, and still present, an oral defense of their research). B.A. students previously lacked the option to complete a senior project, must less present it. Hence, our new and revised programs have extended a culminating experience requirement to all students, and also created expectations and provided training for (poster-style) presentation where none existed before.

On our evaluation instrument, one of the four SLOs (item III) served as a validation check. We knew that none of the students had completed projects designed to meet SLOs III.1 or 2 except perhaps incidentally. Hence, if our evaluators rated this red-herring SLO highly, then we knew that they were probably not telling us anything useful about the other SLOs. However, the four evaluators consistently assigned ratings based on SLO III.1 or 2 (their choice) at level 3 or 4 (that is, the student might have met the SLO but evidence was insufficient to say or lacking entirely, respectively). This gave us confidence that the ratings based on the other three SLOs, which the student projects and posters were more likely designed to address, were likely valid.

When our four external evaluators returned their evaluation forms, all four commented on how impressed they were by the students and their posters, and several were also impressed that we had made a culminating experience and poster presentation a requirement for all students. Based on the three, non-red herring SLOs, the evaluators consistently assigned Likert scale ratings of 1 or 2 (“SLO clearly met” or “SLO probably met, though more evidence would help”, respectively).

We interpret these results very positively, especially since it was the first time we’d required and offered ERTH 690, required a culminating experience for all students rather than about half, offered a senior project option for the B.A., and staged the Earth & Climate Sciences Research Symposium. However, it is clear that poster presentations about senior projects, B.S. Honors Theses, and summer field courses are not going to demonstrate that all students have met SLOs III.1 and 2 because such experiences are not, for the most part, designed to meet these SLOs. We will therefore need to look for appropriate evidence elsewhere, and if we can’t find suitably compelling evidence, we’ll need to revise one or more courses accordingly.
What assessment activities do you plan to undertake next academic year? Will you work on steps to take to improve the student learning outcomes based on these findings (e.g. create signature assignments, change the required courses)?

Since last May, when we conducted the evaluation exercise described above, we were granted funding through the Teagle Curriculum Redesign Initiative to strengthen and coordinate the five core courses plus ERTH 690 required by all Earth Sciences B.S. students and (for the most part) by Earth Sciences B.A. students. Our Teagle proposal outlined a program evaluation strategy focused on these courses, an updated version of which we summarize below.

Assessment of Program SLOs

We envision at least two types of assessment for our Earth sciences core courses and capstone presentation course: (1) a semi-formative assessment of how well assignments in the Earth sciences core courses prepare students for subsequent courses in the program, evaluated by instructors of the latter; and (2) a summative assessment based on student work over time presented in an electronic portfolio and on student work in the capstone presentation course.

We created our Earth sciences core courses to accomplish two broad goals: (1) introduce students to fundamental concepts and knowledge in Earth science; and (2) help students acquire critical thinking, problem solving, and communication skills such as reading technical literature, presenting technical information in writing and orally, recording and interpreting field observations and instrumental measurements, thinking quantitatively and applying methods of data analysis, building and testing models, and using computer software to assist most of the foregoing. Many of our upper division, emphasis-specific courses expect students to have already begun acquiring such knowledge and skills in previous courses, and then build on them. Heretofore we have lacked any systematic strategy for ensuring that prerequisite and other preceding courses prepare students for subsequent courses.

We propose to (1) solicit input from instructors of emphasis- and discipline-specific courses (that is, non-core courses) to guide those who will develop the core and capstone presentation courses; (2) require the core course developers to (a) articulate student learning outcomes for their courses (course SLOs) that reflect this input and (b) design assignments to help students achieve the course SLOs; and (3) once the course is over, ask the discipline- and emphasis-specific course instructors to evaluate the assignments in light of the course SLOs and to recommend modifications as necessary. We call this “semi-formative” assessment because it occurs before or immediately after each core course is taught, not at the end of a full cycle of core course offerings. (We offer each core course once per year.) (Items (1) and (2) were inaugurated during two workshops funded by our Teagle grant in summer 2016.)

For summative assessment of the program, we propose two complementary approaches. One, which we have conducted once already (in May 2016), we describe earlier in this program assessment report. A second, complementary approach will
be to ask majors to create an electronic portfolio of selected work from the core and capstone presentation courses (and some emphasis-specific courses), along with a reflection on how they think each piece of submitted work addresses one or more course and program SLOs. Students will be trained to do this starting in ERTH 205 (“Techniques in Earth Sciences”, 2 units of lab), our entry-level core course, and encouraged to treat their portfolio as an on-line resume to show to potential employers. The Department implements mandatory advising every semester, so major advisors will ensure that their advisees maintain their portfolios to the standards we expect. The portfolios will provide a convenient source of data to evaluate how well students can demonstrate their achievement of the SLOs. We will ask alumni and other professional guests invited to our annual Earth & Climate Sciences Symposium to evaluate not only student posters in ERTH 690, as described earlier in this document, but also randomly selected portfolios of graduating seniors, applying a rubric to determine how well students have achieved selected program SLOs. (The particular SLOs to evaluate will rotate from year to year so that all will be evaluated within several years.) Based on feedback from our external evaluators and ourselves, we will then modify our courses as needed. Preliminary surveys and anecdotal information indicates we have many local alumni willing to take part in these types of assessment.

Are there other assessment findings that you’d like to address?

As noted in the previous section of this report, most culminating experiences completed by our students aren’t designed explicitly to address SLOs III.1 and 2, so we will need to look for appropriate evidence elsewhere, and if we can’t find suitably compelling evidence, we’ll need to revise one or more courses accordingly. Our proposed semi-formative assessment strategy, and possibly the electronic portfolio component of our proposed summative assessment strategy, should help us do that.

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?

We have no plans to revise our program SLOs imminently because we have just begun to use them to evaluate our programs. However, we don’t hold them sacred as currently drafted and will not hesitate to revise them as our goals change or we discover that we can’t use them meaningfully to evaluate our program.

Will you move on to assess a different learning goal?

At least in part, if not completely. However, our inaugural program evaluation exercise used data from only three students (which is all we had in the first year of implementation of our new programs). The results were very positive, but three students are probably not enough to help us spot potential shortcomings in our program, so we might well assess at least some of the same SLOs this academic year.