

Department of Geosciences – San Francisco State University

Assessment Report for Geosciences Undergraduate Programs

May 2011

I. General Background

The Department of Geosciences has three undergraduate majors programs. These include a Bachelor of Science in Geology, a Bachelor of Science in Atmospheric and Oceanic Sciences (with concentrations in Meteorology or Oceanography), and a Bachelor of Arts in Earth Sciences. The B.S. in Geology is the oldest and most established of the three, while the B.S. in Atmospheric and Oceanic Sciences and the B.A. in Earth Sciences have recently undergone major revisions that preclude a detailed long-term assessment of student learning objectives at this early stage in their development. The three undergraduate degree programs are addressed individually in different parts of this report.

II. Bachelor of Science in Geology

Introduction

Since submitting the last assessment report (2010) for the BS in Geology program, the Department of Geosciences has:

1. Reviewed and critically re-evaluated the student learning objectives (Appendix A) for the BS degree in Geology, which were first evaluated in the 2010 Assessment Report. No substantial changes were made.
2. Reviewed and critically re-evaluated the matrix that shows where those learning objectives are embedded in the curriculum, which was first evaluated in the 2010 Assessment Report. No substantial changes were made.
3. Reviewed and critically evaluated the detailed outline of specific student learning objectives for each of the required basic core courses in our BS degree in Geology, which was developed in 2010 to demonstrate how each of the course learning objectives correspond with overall program learning objectives. No substantial changes were made.
4. Reviewed and critically evaluated the strategy that was developed in 2010 to measure the outcomes at the program level. This strategy has provided valuable information, but we need to expand the assessment activities to include benchmarks available through nationally-vetted assessment instruments. These changes are detailed below.

Broad Student Learning Objectives for the BS Geology Program

For the BS in Geology program, the Department of Geosciences has established four broad student learning objectives aimed at developing the following competencies in our students:

A. Ability to investigate geologic problems by making observations and collecting data in the field/laboratory

B. Ability to analyze and interpret geologic data in terms of geometric, spatial, and temporal relationships

C. Ability to effectively communicate results of geologic investigations in written and oral formats, and to integrate previous research results

D. Ability to use scientific principles to address societal issues such as natural hazards, resource utilization and conservation, and environmental change

Note that we previously had a fifth learning objective (E. Ability to design and implement a geologic investigation with faculty supervision), that was removed when the BS in Geology curriculum was revised several years ago. Students are no longer required to complete a senior thesis, but may choose instead to complete a rigorous summer field course as their capstone requirement.

Each of these four broad student learning outcome categories encompasses a group of more specific learning outcomes that can be measured in courses across the program. Each specific learning outcome, together with the courses in which each outcome is measured, is listed using a matrix format in Appendix A. For example, under broad learning objective A there are 10 specific learning objectives. Objective A5: “Collect basic structural data in the field” is measured in all 7 required courses listed in Appendix A, whereas objective D1: “Recognize geologic hazards and understand their causative processes” is measured in two courses: GEOL 120 and GEOL 430. In the 2010 Assessment Report, Appendices B through H described the overall course learning objectives for each of seven required courses in the Geology program (GEOL 110, 115, 120, 420, 430, 460 and 695), as well as the specific learning objectives for each principal course activity (e.g., labs, reports, and exams). The course activities listed in Appendices B through H are in turn linked to one or more of the specific program learning objectives (e.g., A1, A5, B2, B3....) detailed in Appendix A. Appendices B through H are not included in this 2011 Assessment Report, but remain an important component of our assessment in linking the five broad program learning objectives with learning objective in the required 7 courses.

Assessment methods for the BS in Geology Program—Overview

After extensive discussion and coordination in 2010, the program faculty decided to base the 2010 assessment of student learning outcomes on student performance on individual course activities, including labs, written reports, oral presentations, or exams. For ease of

comparison across courses and activities, student performance in each activity was scored on a scale of 0 to 10, with 10 representing a perfect score for the activity in all courses. These scores were summarized in histogram form in Appendix I of the 2010 Assessment Report.

In 2011, program faculty further analyzed the scores summarized in Appendix I of the 2010 Assessment Report, focusing on the considerable variability in the data and lack of apparent trends over time. After careful deliberation, we recognized that our approach would not provide an effective method of assessment due to the inherent difficulty of making objective comparisons across widely differing courses. Therefore, we agree with Linda Buckley's memo from May 19, 2010 that stated "...variability of the data on activity scores for this program is problematic because it's hard to know how to make sense of the results with such variability." However, we feel this was still a valuable assessment activity because it enabled us to analyze how the learning objectives were being addressed across the curriculum. We were gratified to see (as demonstrated in the Appendix A matrix) that all faculty teaching required majors courses have included activities that assess the overall program learning objectives. All of the learning objectives are addressed in at least two courses and most are addressed in nearly all of the required courses. This analysis has made us more aware of what is being taught in the required courses, and has helped us to coordinate more closely the activities in these courses. The variability in scores among the various courses reflects differences in the structure of the courses, as designed by individual faculty to meet their learning goals, and the way that each activity is evaluated. Because of this variability, we recognized the need to establish benchmarks that are not subject to individual course structures, and that can provide an objective approach that demonstrates more clearly our students' accomplishments.

An assessment program is only as valuable as its ability to enable us to gauge the effectiveness of our program over time, and to show us how to integrate change where necessary. Our challenge was to identify an alternative method(s) to objectively and effectively assess the overall program and specific course learning outcomes, and to integrate meaningful, quantitative benchmarks with which to compare student learning outcomes. We have identified two nationally available and thoroughly vetted assessment methods that hold considerable promise: (1) the National Association of State Boards of Geology (ASBOG) Fundamentals of Geology (FG) exam, and (2) the Critical Thinking Assessment Test (CAT) developed by the National Science Foundation (NSF). The Geology faculty are familiar with the FG exam, and Karen Grove and Dave Dempsey are currently using the CAT as part of a NSF-funded project to improve introductory courses in the Department of Geosciences. More importantly, the FG and CAT exams are proven indicators of the skills we hope to impart on our students. The following sections describe the FG exam and CAT and our plan to implement them as assessment tools.

ASBOG Fundamentals of Geology (FG) Exam

The ASBOG FG exam and Practice of Geology (PG) exam are standardized written examinations for determining qualifications of applicants seeking licensure as

professional geologists in nearly all states. The exams have been designed and validated to measure the competency related to the practice of the professional geologist. The FG and PG examinations are developed following guidelines established in the Standards for Educational and Psychological Testing (1999) published by the American Educational Research Association, the American Psychological Association, and the National Council on Measurement in Education. The procedures are designed to maximize the fairness and quality of the examinations. In California, practicing geologists must obtain licensing as a Professional Geologist (PG) to sign off on geologic reports and generally comply with State Law regarding professional geologists. Passing the FG and PG exams are two requirements to obtain the PG license. The FG exam can be taken upon completion of a BS degree in Geology and the PG exam can be taken after the FG exam and 3 years of professional experience. The FG and PG exams consist of 130 and 100 questions, respectively, and must each be completed within 4 hours.

Our program learning outcomes (Appendix A) are well aligned with the content of the FG exam (Appendix B). Furthermore, ASBOG's list of courses expected for a solid undergraduate foundation in the field of geology are represented in the 7 required courses for our BS degree in Geology (Appendix A): physical geology (GEOL 110), historical geology (GEOL 115), mineralogy (GEOL 420), petrology (GEOL 420), structural geology (GEOL 430), stratigraphy (GEOL 460), and field geology (GEOL 120 and 695). Therefore, we are developing a mock scaled-down version of the FG exam that will be administered to graduating seniors during the end of their last semester. Students' overall and domain (Appendix B) scores on the mock FG exam will be compared to the publically-available national FG exam scores from ASBOG. The national scores will provide an objective benchmark to compare student learning outcomes and enable us to effectively identify any deficiencies in our program. An important additional benefit of this assessment method is that SF State students will become knowledgeable of the requirements for the PG licensing process, and they will gain valuable experience by taking a mock FG exam prior to the official FG exam they can choose to take after graduation.

Critical Thinking Assessment Test (CAT)

The CAT has been developed by faculty at Tennessee Tech University over a period of about 10 years. It is designed to assess and promote the improvement of critical thinking and real-world problem solving skills. The instrument is the product of extensive development, testing, and refinement with a broad range of institutions, faculty, and students across the country. The NSF has provided support for many of these activities. Questions are derived from real-world situation and most require short-answer essay responses. A detailed scoring guide helps ensure good scoring reliability. The CAT has been shown to correlate with other critical-thinking measurement tools, to have high scoring reliability, to be internally consistent and culturally fair, and to be sensitive enough to reveal differences in critical-thinking ability in a single class and with a small sample size. For more information about this instrument:

<http://www.tntech.edu/cat/home/>

Three Department of Geosciences faculty (Grove, Dempsey, Dekens) currently have an active NSF grant aimed at improving introductory-level geoscience courses that are part of the University's general education program (Segment II). Grove and Dempsey attended a two-day workshop, where they were trained to implement and score the CAT instrument. They learned how the CAT instrument could be used for a variety of assessment goals, including evaluating the effects of a single course, or evaluating the effects of a program of study. They decided to use the CAT as a pre-course/post-course assessment instrument in the newly-designed introductory geosciences courses. In May 2011 they administered the CAT at the end of the spring semester, and in the Fall 2011 semester are administering the CAT at both the beginning and end of the semester. They have organized two scoring workshops (in May 2011 and September 2011) that consisted of 10 faculty and graduate student instructors. The workshops meet two goals: (1) CATs are all scored using a detailed rubric; (2) professional development for instructors who think about how they can more effectively include activities in their courses to improve students' critical-thinking skills.

After learning about the CAT, the faculty felt that this instrument could also be used to effectively assess our learning objectives for the BS in Geology program. The CAT consists of 15 questions, and each question aims to assess one skill related to critical thinking (Appendix C). All of these questions (Q1–Q15) aim to assess students' abilities to evaluate data and solve problems, the essential aspects of the first two learning objectives we have for the students in our BS in Geology program (Appendix A, learning objectives A and B). In addition, many questions measure students' ability to communicate their ideas in a written format; points are awarded in 9 of the 15 questions for effective communication (Appendix C—Q2–Q4, Q6–Q7, Q9, Q11, Q14–Q15). This addresses our third learning objective (C in Appendix A). Because the CAT has been used by a large number of institutions across the country, our results can be compared with national means of students at a similar academic level.

Because the CAT provides a nationally-recognized benchmark (national means) for comparing our students' progress during the major, we are administering the CAT in the first and last of the required courses for our BS in Geology program. Although the Geol 110 is the first required course, many of the students complete this course at a community college. We therefore decided to administer the CAT in Geol 120, the second course in the program, which has a prerequisite of only the Geol 110 course. Students typically take this course as sophomores or juniors. We also decided to administer it in the Geol 695 course, which students take after they have completed all of the other required courses. They are typically seniors when they take Geol 695. Geol 120 is offered every Fall semester and Geol 695 is offered every Spring semester.

Preliminary results. In Spring 2011, we administered the CAT in Geol 695 (n=9 students) and, scored them during our May 2011 workshop. Scored CATs were then returned to Tennessee Tech's Center for Assessment & Improvement of Learning, who during the summer sent us a formal report about the results (Appendix C). Students in Geol 695 scored as well as, or better than, the national mean (compared to other college seniors) for all questions (Q1–Q15). The overall score (26.22) was significantly better

than the national mean (19.04). Of particular note is a result for Q14, the most complex question that has the highest point value (5 points possible, in total). This question aims to measure how well students can “identify and explain the best solution for a real-world problem using relevant data”. Our students’ mean score (4.00) was significantly better than the national mean (2.29) for this question. Practicing geologists must integrate data that vary widely in type, quality, and scope, so we are gratified to see how well students did with this complex question. We have administered the CAT at the beginning of the Fall semester in the Geol 120. We have scored the CAT in our workshop, but have not yet received a report about the results from Tennessee Tech. We will compare results between the Geol 120 and 695 courses, to assess how well they have achieved our program learning objectives. This will be particularly valuable once we have data from the same students who have traversed through the program.

Summary

A continued benefit of this process has been the increased communication among instructors, who are now much more aware of what is being taught in all our required courses. We are continuing to communicate more effectively about how to best coordinate topics among courses and build upon what students have already learned in prior course activities. This has improved our communication to our students the individual course learning objectives and how these course objectives articulate with the overall program objectives.

Our ongoing and future assessment efforts include the following:

1. As described above, our analysis of the learning objectives is leading to better understanding of the curriculum and better communication among the instructors. We are using this analysis to improve coordination among the courses. We will continue to monitor our courses and make adjustments based on the results from our revised assessment tools.
2. To help students have more successful in their courses, we are looking at the timing of major assignments in the core classes that students commonly take concurrently.
3. As described above, we are establishing a work plan to create a mock, scaled-down FG exam that will be administered to graduating seniors this Spring 2012. We will compare those exam scores to national scores. The mock FG exam will consist of available sample questions from ASBOG.
4. We have already administered the CAT in Geol 695 and 120, bookends of the required set of courses for our majors. We have already seen encouraging results from the Geol 695; further analyses will be provided as we have more results.
- 5.

III. Bachelor of Science in Atmospheric and Oceanic Sciences

Introduction

The Bachelor of Science in Atmospheric and Oceanic Sciences was established in 2000 as a result of the Department of Geosciences’ response to Program Review mandates

made in 1997. At that time, our vision was to include a common core for both concentrations within the degree: Meteorology and Oceanography, hoping to add future oceanography faculty hires to the three meteorology and one oceanography faculty in place at the time. The provisional curriculum in place at the time was designed around American Meteorological Society (AMS) requirements for B.S. meteorology degree certification. As such, it was a transitional plan that did not include sufficient faculty resources to mount an effective oceanography concentration.

The recent addition of oceanography professors Petra Dekens and Tim Janssen to the Department's faculty (Fall 2007 and 2008, respectively) provide a full complement of faculty from both disciplines. Accordingly we reorganized the curriculum of this B.S. degree to better serve students in both degree concentrations. Our curriculum for this program capitalizes on the close collaboration of faculty from both disciplines to emphasize the linkages between the two fields and prepares our students to make contributions to addressing urgent societal needs impacted by the ocean/atmosphere system. This program occupies a unique niche in the CSU system in that the two fields are woven throughout our curriculum in both concentrations, unlike the stand-alone programs such as Meteorology at San Jose State or Oceanography at Humboldt State.

Meteorologists world-wide agree on the subject matter that a student must master to obtain a B.S. degree, as is officially defined by the World Meteorological Organization, a U.N. agency. At the national level, the AMS specifies a set of criteria that an institution must meet to offer a B.S. degree in Meteorology (including minimum levels of faculty staffing and curriculum). Our B.S. program fully meets the AMS guidelines, as well as some additional requirements specified by the national Weather Service, the largest single employer of meteorologists in the US.

In contrast to meteorology, oceanography is a more interdisciplinary and broader field. The oceanography professors have developed a curriculum for the Concentration in Oceanography within this degree that provides oceanography concentration majors a background in the fundamental areas of the discipline and more in-depth competencies in particular areas of expertise strength and research interest of the faculty members. The meteorology faculty, at the same time, has revised the meteorology concentration curriculum to allow meteorology concentration students to better integrate knowledge of oceanography, global climate change, and the evolving quantitative and communication skills currently demanded by the profession.

A distinguishing feature of this B.S. degree program is the extensive set of pre-requisites for the majors courses, many offered by the Mathematics and Physics and Astronomy departments. This poses a significant advising challenge to students entering the program, since many decide to become majors at a point where they need to make up deficiencies in their math and physics competencies before proceeding with required majors courses. Although the introductory GE courses our department offers in meteorology and oceanography (currently METR and OCN 100 and 101) are not required for the major, these courses are a primary recruitment ground for new majors, and provide us with the

opportunity to advise students to take the requisite math and physics courses in time to graduate without unnecessary delays.

These introductory GE courses are in the process of being completely redesigned with the help of a major grant we recently received from the National Science Foundation, and will be offered in all three disciplines (Geology, Meteorology and Oceanography) starting in Fall 2010. We are hoping that the new courses (now labeled GEOL 104, METR 104 and OCN 104) will help us not only recruit new students into the major, but also allow us to provide timely advising to help them achieve the student learning objectives for this major.

The six members of the Department of Geosciences faculty that teach in this program have produced a mission statement for the program, a set of program-wide student learning objectives and a curriculum and roadmap to graduation for the program. With the two new oceanography professors now in place, a two-year course rotation schedule is being set up so that students in both concentrations encounter a minimum of delays on their way to graduation. We created a “common core” that both meteorology and oceanography students will take as part of their B.S. Minor revisions of the common core now in place will be submitted to the Curriculum Review and Approval Committee of the Academic Senate in Fall 2010.

Mission statement

The mission of the BS in Atmospheric and Oceanic Sciences is to provide students with a foundation in oceanography and meteorology that has a unique focus on the relations and general principles across these disciplines. The program is dedicated to preparing students to successfully contribute to important societal issues, such as global climate change, coastal impacts and weather forecasting, and be successful in a wide range of careers in applied meteorology and oceanography, as graduate students, teachers or in industry.

Broad Student Learning Objectives in the B.S. in Atmospheric and Oceanic Sciences

A. Scientific Principles and Methodologies

Students will develop and demonstrate understanding of the scientific principles and methodologies as they apply to the study of the atmosphere-ocean system, the value and inherent uncertainty in observations and model predictions, and the role of empirical and theoretical research in scientific progress. They will acquire an appreciation for how these fields have developed, and of the role peer review plays in the funding of research and publication of results.

B. Phenomena and processes in the ocean and atmosphere

Students will develop and demonstrate understanding of the fundamental physical basis of the ocean-atmosphere system, including the spatial and temporal scales of processes that take place in the system, the transport cycles of e.g. water, carbon and energy through the ocean-atmosphere system, and the implications for the local and global climate.

C. Application to societal issues

Students will develop and demonstrate the ability to apply skills, knowledge, and research findings to critically assess issues related to how the ocean-atmosphere system affects society.

D. Critical thinking and communication

Students will develop and demonstrate the ability to effectively communicate attainment of learning objectives 1-4, using oral, written and visual media.

We are following the process we used in the B.S. in Geology program (see Appendix A) to develop a set of more specific student learning objectives under each of the four broad categories listed in Table 1 on the next page. Specific student learning objectives falling under each of the four broad categories listed above are currently under active discussion and will be in place before the start of the Fall 2010 semester.

TABLE 1

Objective	Place in curriculum where objective can be assessed	Method of Assessment
<i>A. Scientific Principles and Methodologies</i>	METR 201, OCN 200, METR 400, METR/OCN 405, GEOL 458	Based on performance on exams and written reports, details being discussed
<i>B. Phenomena and processes in the ocean and atmosphere</i>	METR 201, OCN 200, METR/OCN 202, METR/OCN 320, METR 400, METR/OCN 405, METR 410, METR 420, METR 430, METR 450, METR 520, METR 530, OCN 420	Based on transcript analyses, performance on exams and written reports, details being discussed
<i>C. Application to societal issues</i>	METR/OCN 405, GEOL 458, CHEM 680, METR/OCN 756	Based on performance on exams and written reports, details being discussed
<i>D. Critical thinking and communication</i>	METR 400, METR/OCN 405, GEOL 458	Based on performance on exams, written reports and oral presentations, details being discussed

Assessment methods for the BS in Atmospheric and Oceanic Sciences

We are following a multi-pronged set of assessment methods for this degree program. As we did with the B.S. in Geology Program, we will assess student learning outcomes using student performance on individual course activities, whether labs, written reports, oral presentations or exams. For ease of comparison across courses and activities, student performance in each activity will be scored on a scale of 0 to 10, with 10 representing a perfect score for the activity in all courses.

In addition, we will be administering the survey instrument described in Appendix J to students graduating from this program, starting in Spring 2010, and we are discussing the potential use of electronic portfolios as an assessment tool in this program.

Analysis of Assessment Data and Assessment analysis plans for 2010-2011

Assessment of broad student learning objective B

Since this program has the most extensive and inflexible course pre-requisite structure in our department, we conducted a transcript analysis of students that have graduated from the meteorology concentration in this program (and its predecessor) to determine how well and when the prerequisites have been fulfilled by students in this concentration in the last 15 years.

For instance, before taking METR 410, Atmospheric Thermodynamics and Cloud Physics, a student must have taken Physics 220 in a previous semester, which in turns requires students enrolling in that course to have passed MATH 226 with a grade of C or better and received a satisfactory score on a physics placement exam. This long chain of pre-requisites places a large burden on students that “discover” meteorology after being at SFSU for more than a year. Considering that the typical entering SFSU student, whether “native” or transferring from a community college has not taken Calculus (Math 226) or is even prepared to take that course, we have had to make compromises by waiving some of the math and physics prerequisites so students take those courses concurrently rather than previously. The problem gets compounded as the unprepared meteorology student proceeds with the program, as the math and physics prerequisites increase with the level of meteorology courses the student takes.

We performed a transcript analysis of students that graduated from the meteorology program in the last 15 years. Several facts emerged from this analysis:

- 1) A majority of students had to delay their graduation time beyond four years as a result of the need to complete prerequisites to the majors’ required courses.
- 2) Although METR 100, Introduction to Meteorology, is not a required course for the major, the transcript analysis showed that almost all students that graduated from this program took this course - often in their second or later year at SFSU. At that point, when they come in for advising, students often find about for the first time about the extensive pre-requisite structure for this major.
- 3) We noticed that the enrollment for the meteorology program had dropped off during the period of several years that the METR 100 course was taught by a non-tenure track part-time lecturer. This situation was corrected starting in Fall 2009, when the Metr 100 course began to be taught once again by the meteorology professors. This has resulted in an increase of majors and potential majors taking the METR 201 class, a required gateway majors class, this semester. This also allows potential majors to be reached earlier with the information they need about prerequisites so their graduation is not delayed unduly.
- 4) A critical course that our majors in this program student should ideally take in their 4th or 5th semester is MATH 228 (Calculus III, which covers three-dimensional analytic geometry, partial differentiation, multiple integrals, and vector calculus). Of a sample of

21 students that graduated from the meteorology concentration (or its predecessor), only 6 had completed this course during the 4th semester, while 10 completed that course during their 6th semester or later. Students in this latter category either had to postpone graduation or take this course concurrently with majors courses, a less than ideal situation that forces us to slow down the content delivery of our advanced courses while we ensure that students have the necessary quantitative skills to successfully complete our advanced required classes.

5) Another problem that has been apparent to the meteorology faculty has been the attrition that occurs when students take the METR 420 class, Dynamic Meteorology, which is a particularly challenging class (with METR 410 and additional physics and math courses as prerequisites) where students study the forces that govern atmospheric dynamics. Traditionally, this course is offered ahead of METR 430, Synoptic Meteorology, where students get to apply the concepts learned in METR 420 to real-time weather forecasting situations.

Actions taken as a result of assessment analysis and future assessment plans

1) Prof. Janssen, a physical oceanographer with particular interest in the use of quantitative methods, proposed the creation of a new course, the METR/OCN 320 class, which will address topics covered in MATH 228 using specific examples drawn from the fields of meteorology and oceanography. The course will be offered for the first time in Spring 2011, and will replace one of the Physics course requirements for the majors, so as not to exceed the number of units required for this program. We expect that this course will help address the broad student learning outcome B in Table 1 above and will assess its student learning outcome in the coming years.

2) After much consultation and study of other meteorology programs across the nation, we have decided to modify aspects of METR 430 to make it more accessible to students at an earlier stage in their careers. The hope is to give students better motivation to go into greater depth into the physical basis for atmospheric dynamics, what METR 420 accomplishes, by seeing a “preview” of applications of this knowledge ahead of taking METR 420. This change in the sequencing of the meteorology curriculum will be implemented in Fall 2010. We will monitor the student experience with the new course sequence closely.

3) We will complete the specific student learning outcomes for both concentrations in time for the start of Fall 2010, so that course activities, tied to learning outcomes, are in place. We will include learning outcomes of these assessments in next year’s report.

IV. Bachelor of Arts in Earth Sciences

This program was only recently put in place (Fall 2008) and the first group of students is graduating in the 2009-2010 academic year.

Mission Statement

The mission of the B.A. in Earth Sciences is to provide students with an understanding of how the physical earth works, based on the fundamental principles of geology, meteorology, and oceanography and how these principles must be integrated to address complex problems in the earth sciences; an understanding of how scientists produce new knowledge about the physical earth; an understanding of both the impact of earth processes on human societies and of human activities on the physical earth; and the ability to communicate with scientists and the public about, and contribute to solutions to, practical problems arising from interactions between people and the physical earth.

Program Learning Objectives

Broadly speaking, students completing the B.A. program in Earth Sciences should acquire content knowledge about the physical earth and interactions between the physical earth and humans, an understanding of the way science works in the earth science disciplines, and the ability to communicate their knowledge and understanding.

More specifically, upon completion of the B.A. program in Earth Sciences, students should demonstrate the ability to:

(A) conceptualize a set of fundamental processes in the physical earth system, including spatial relationships, temporal change, and how components of the earth system (land, air, and sea) interact;

(B) articulate the process of geoscientific investigation and locate, read, interpret, and evaluate presentations of earth science information in the mass media, in government reports, and in the geosciences literature for their relevance and credibility;

(C) explain relations among earth processes and human actions and how humans across cultures and economic levels can live safely and sustainably on the planet; and

(D) communicate earth science concepts and information effectively, both orally and in writing.

Assessment Methods for the B.A. in Earth Sciences

This program is being assessed in a similar manner as our other two undergraduate programs, namely by student learning outcomes on student performance on individual course activities, whether labs, written reports, oral presentations or exams. Since the required courses for this major often overlap courses offered in our other two undergraduate programs, we are in the process of developing specific student learning objectives under the four broad categories listed above, and will tie individual course activities to these specific objectives.

Analysis of Assessment Data and Assessment analysis plans for 2010-2011

Since this program provides the students with more flexibility in course selection than our B.S. courses, we will focus our assessment analysis on four courses that serve as either “gateway” (GEOL 104, METR 201 and OCN 200) or “capstone” courses (GEOL/METR/OCN 405). Assessment of the gateway courses will provide us with data on the acquisition of basic quantitative skills and familiarity with the scientific method at an early stage of the career, while the capstone G/M/O 405 course can provide assessment data at a point where students are near to completion of their degree.

GEOL/METR/OCN 405, “Planetary Climate Change” (3 units lecture, 1 unit lab) is required for students in both the B.S. program in Atmospheric and Oceanic Sciences and in the B.A. program in Earth Sciences. It is also an elective for students in B.S. program in Geology, the B.S. program in Environmental Studies, and the Liberal Studies program. Moreover, it was designed originally to help pre-service high school science teachers meet geosciences subject-matter requirements for admission to California teaching credential programs, so pre-service teachers majoring in Biology, Chemistry, and Physics also take the course.

The course integrates multiple disciplines, including meteorology, oceanography, geology, physics, chemistry, mathematics, astronomy (planetary science), and some biology, to address the fundamentally interdisciplinary problem of planetary climate change. Because it draws on multiple physical science disciplines and is designed to serve students with a relatively wide range of backgrounds (from Liberal Studies to majors in one of the geosciences), it is not reasonable to make any particular course a prerequisite for GEOL/METR/OCN 405. At the same time, we teach the course as an upper division science majors course (consistent with its prefix and number), which assumes that students already have a relatively high level of critical thinking, graph reading, communication, and computer skill, and to a lesser extent quantitative thinking skill, as well as substantial geographic and other basic knowledge about the world, how it works, and how we describe its features and measure its properties. Ideally, the course functions as a kind of senior-year capstone course, pulling together and applying a wide range of disciplinary knowledge and skills that students acquire over the course of an undergraduate education.

The high expectations that we place on students in the course, together with the wide range of students that the course serves and the difficulty of specifying any particular prerequisites, presents a dilemma. For a number of years, we have set the prerequisite at 6 units of physical science coursework, which all students from all of the course’s potential audiences can meet by their senior year. This prerequisite is relatively weak, but we have hoped that the course’s science-department prefix and upper-division level numbering, together with appropriate advising, would send sufficient signals about the level of expectations we have for students to succeed in the course.

However, in Fall 2009 a significant number of students enrolled in the course who were only marginally prepared. They met the minimum prerequisite but barely, and (based on

transcripts) not well. The instructor (Dr. Dave Dempsey) offered a gentle warning at the beginning of the semester that they would likely struggle with the course and that they would get more out of it if they waited a year or two and built a stronger foundation in physical sciences first. However, in the face of major budget cuts to the University and the consequent scarcity of available classes, most of them were desperate to find a course—any course—in which they could enroll, and they chose not to heed Dr. Dempsey's advice.

In Spring 2000, Dr. Dempsey analyzed the history of grades assigned in GEOL/METR/OCN 405, looking for any systematic relation between grades earned and level of preparation of the students. Since Fall 2000, when the course was created, Dr. Dempsey and five different co-instructors have taught the course eight times to a total of 85 students (not counting a couple of students who didn't complete the course). The average number of grade points earned by those 85 students was about 2.8 (just above a B-).

Based on prior coursework completed, well prepared science majors (including B.S. students in Environmental Studies in that group) earned a wide range grades in G/M/O 405. Some were superb, and if SFSU had an "A+" grade then several would have earned it. Others simply didn't perform, either because they couldn't or wouldn't, and earned "C"s of various kinds (though one "D+" was assigned, and a few others were spared only by the generosity of the instructors).

In contrast, the two Liberal Studies students who were both well prepared (in terms of the number of physical science courses they'd taken, albeit entirely GE courses) and had high GPAs (including their physical science courses) earned a "B" and a "B-", respectively. This is respectable, but they had to work hard for those grades. This tells us that the course isn't comparable to a GE course—it is functioning as a science majors' course, as intended.

Five other Liberal Studies students and one freshman psychology major who technically met the prerequisite (6-units of physical science) but didn't have strong academic records and had taken only GE courses (two courses each), all earned "C" or "C-" grades. Moreover, they seemed clearly out of their depth all semester. The same was true of one Earth Sciences major and two Biology majors who were still relatively early in their academic careers and barely met the prerequisite (and in addition did not have strong transcripts); two of these students earned "D+" grades.

As an anomaly, one freshman geology major whose only previous college-level physical science course was GEOL 110 (though she was taking several others the same semester as G/M/O 405), earned an "A". (Although her academic record was very limited, it was nearly perfect. She was a rare student!) Altogether, of the 85 students who have completed the course, thirteen earned an A and another seven earned an A-. All of those, except for the one freshman, were experienced students (several were graduate students) and almost all were science majors (one was a non-B.S. Environmental Studies student with 160 units of college work under his belt, a transfer from UCLA).

Underprepared students clearly have a hard time grasping the concepts and style of thinking, reading, and writing that we expect of students in G/M/O 405, whereas more experienced students often thrive. This seems clear based not only on final grades but also on in-class interactions with the instructors and performance on individual assignments.

Based on his analysis, Dr. Dempsey submitted a course revision proposal to strengthen the prerequisites from 6 units of physical science coursework to 9 units. We shall see if this sends the message more clearly about the level of preparation that we expect.

We expect to present a fuller assessment report for this new program in next year's report