# UNIT ASSESSMENT PLAN 2006-2007

## Name of unit: Earth Science

## Primary assessment contacts: Dr. Steve Taylor and Dr. Jeff Templeton

**I. Statement of unit mission:**[i]
The Earth Science program provides a liberal arts core education in geoscience with an emphasis on the scientific method, problem solving, and interdisciplinary science education. A key objective of the program is to prepare undergraduates for careers as professional geoscientists and educators. The program also promotes the development of an informed citizenry for wise decision-making on issues related to natural resources, environmental quality, and sustainability in Oregon and beyond.

**II. Unit intended objectives/outcomes**[ii]:
**1.** Acquire a comprehensive understanding of the interrelated physical, chemical, and biological processes operating in the Earth system.
**2.** Develop proficiency in using technology-enriched analytical techniques to solve geologic problems.
**3.** Gain experience in conducting inquiry-based science in the context of outdoor adventure.

**III. Tactics for achieving the objectives:**
1. A newly reorganized B.S./B.A. Earth Science major was approved by WOU/OUS administration in 2000-2001; the new major was implemented in the catalog in 2001-2002. The original intent for creating a new Earth Science major at WOU was to align the curriculum with nationally-recognized education standards and to update the program to better prepare graduates for careers as scientists and educators in the 21st century.

2. Earth Science courses are directly aligned with the learning objectives in listed section II, according to the matrix provided below.

**EARTH SCIENCE Program mission statement**

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| Program student learning outcomes | Courses that have no contribution to learning outcome | Courses that have minimal contribution to learning outcome | Courses that have moderate contribution to learning outcome | Courses that have extensive contribution to expecting mastery of learning outcome |
|---|---|---|---|---|
| Acquire a comprehensive understanding of the interrelated physical, chemical and biological processes operating in the Earth system. | | | ES301, ES 302, ES 303, ES 453/553 | ES 104, ES 105, ES 106, ES 201, ES202, ES 203W, ES 321, ES322, ES 331, ES 390, ES 392, ES 407, ES 431/531, ES 450/550, ES 454/554, ES 458/558, ES 460/560, ES473/573 ES476/576, ES 491/591, ES492/592, GS 351 |
| Develop proficiency in using technology-enriched analytical techniques to solve geologic problems. | ES 203W, ES 453/553 | ES 302, ES 331, ES 392, ES 431/531, ES458/558, ES 491/591 | ES 104, ES 105, ES 106, ES 201, ES202, ES 321, ES322, ES 390, ES 454/554, ES 458/558, ES 460/560, ES473/573, GS 351 | ES301, ES 303, ES 407, ES 450/550, ES476/576, ES492/592 |
| Gain experience in conducting inquiry-based science in the context of outdoor adventure. | ES 104, ES 105, ES 106, ES 203W, ES 331, ES492/592 | ES 201, ES202, ES 303, ES 390, ES 407, ES476/576, GS 351 | ES322, ES 431/531, ES 450/550, ES 453/553, ES 460/560, ES473/573, ES 491/591 | ES301, ES 302, ES 321, ES 392, ES 454/554, ES458/558 |

**IV. Basic approach for assessing our unit intended objectives/outcomes[iii]**

**Formative Assessment**

Formative assessment of Earth Science students is performed on a course-by-course basis with a range of traditional methods including inquiry-based lab exercises, writing assignments (informal short essays and longer-form expose), short active-learning exercises, oral group presentation, multi-media work samples, and objective quizzes and exams (essays, multiple choice, true/false, lab practicum). The style and level of formative assessment tool varies according to instructor and course content. Some courses are based on quantitative problem solving and computer applications (e.g. ES 301 Quantitative Methods, ES 321 Structural Geology, ES 492 GIS Applications, ES 476 Hydrology), others focus on lab and field techniques (e.g. ES 302 Field Methods, ES 303 Petrographic Microscopy, ES 450 Petrology), still others on written/oral multi-media presentation (e.g. ES 473 Environmental, ES 453 Geology of the Pacific Northwest, ES 454 Volcanology).

As highlighted in the Student Learning Outcomes section, the focus of our program is on proficiency in quantitative techniques, technology applications, multi-media communication, and problem solving through application of the scientific method. Geoscience curriculum by its very nature is activity-based and involves outdoor adventure, field trips, hands-on lab exercises, geological conundrums, and problem-solving sets. All of these active learning strategies are employed as formative assessment tools to varying levels on a course-by-course basis in our program.

**Summative Assessment**

Senior Seminar (ES 407) serves as the degree-program assessment tool and capstone evaluation for majors preparing to graduate from the Earth Science program. Students are required to complete ES 407 during the final term of their senior year. The objective of the course is for students to conduct in-depth study and research on relevant topics in the Earth Sciences, by requiring students to draw on information from the full range of major courses they have completed during their time as an undergraduate. A department-wide seminar session is conducted at the end of the term, providing students with an opportunity to demonstrate proficiency in the Earth Science content areas. Seminar sessions are modeled after theme sessions at professional meetings, and each student is required to give an oral presentation. Senior Seminar employs inquiry-based, work sample techniques to demonstrate student proficiency in Earth Science content areas. Students are required to satisfactorily complete the capstone course to graduate from the program. Although ES 407 was initially conceived and placed into the catalog during the 2001-2002 academic year, it is a work in progress and was implemented in earnest during the past three academic years (2003-2004, 2004-2005, 2005-2006). During the present academic year (2006-2007), the seminar work sample methodology will be dove-tailed with the rejuvenated, university-wide, Academic Excellence Showcase event sponsored by the Phi Kappa Phi honor society and the Program for Undergraduate Research Experience. This linkage between ES 407 and the Academic Excellence Showcase was pilot tested last year (2005-2006) and was well received by students, faculty, and parents; however no evaluation metrics have been employed to definitively measure efficacy.

In conjunction with seminar work-sample method described above, a capstone standardized exit exam was initially conceived and implemented during Spring Term 2005. It too is a work in progress and is actively being developed at the time of this writing. The exit exam is based on national standards established by the Educational Testing Service and was formerly part of the Geology Graduate Record Exam used to evaluate entrance qualifications into graduate school. While ETS no longer offers the GRE Geology exam, Earth Science faculty have adapted the question sets from two editions of the ETS Geology Preparation Manuals (1st ed. 1988, 2nd ed. 1996). Exam questions were captured in digital format and imported into the WebCT class management software system for online testing and automated scoring. Exit exam procedures are modeled after those of the GRE. Students are provided practice exams and instructional materials to prepare for the test. Exam results are scored and ranked in comparison to national standardized results from Geology/Earth Science graduates in the U.S. during the late 1980's and mid 1990's.

In addition to GRE-style procedure above, Earth Science faculty are also exploring other standard exit exam tools. One is the education-based PRAXIS exam for teaching candidates with an emphasis in Earth and physical science content. Two recent Earth Science graduates completed this exam for entrance into the Masters of Art in Teaching program at WOU. The other summative assessment tool that is currently being evaluated is the Fundamental Geology Exam that forms part of the Oregon State Board of Geologist Examiners (OSBGE) professional licensing process. The state of Oregon utilizes a nationally standardized process for professional licensure of engineers, geologists, engineering geologists, landscape architects, and land surveyors. The initial registration in the professional geologist certification is that of "Geologist-in-Training" (GIT), which includes successful completion of 45 upper-division credit hours in geoscience and passing a nationally standardized fundamental geology exam that is offered through the Association of State Boards of Geology (ASBOG). OSBGE and ASBOG are currently in communication with geoscience programs throughout the state of Oregon, encouraging them to adopt the fundamental geology exam as a summative evaluation tool for Earth Science / Geology graduates. One of our recent graduates from the Earth Science program passed the ASBOG Fundamentals Exam

in 2005, but the tool has not been systematically adopted. The primary limitation to adopting the ASBOG fundamentals exam is the cost required of students to apply for the initial OSBGE GIT license and fundamentals exam (currently ~$300).

**Post-Baccalaureate Impact/Assessment**

The Earth Science program lacks an organized and systematic post-baccalaureate assessment tool. There has been some informal discussion of creating such a system, and developing a related alumni newsletter, but no action has been taken to date. The only post-baccalaureate data available is that from informal correspondence and networking between graduates and faculty (e.g., emails, phone calls, requests for recommendation). Most of this data is anecdotal and collected within the first six months after students exit the program.

**B. RELEVANT QUANTITATIVE AND/OR QUALITATIVE EVIDENCE[iv]:**

No systematic data analysis or comprehensive program evaluation has been completed for Earth Science. There is a significant need for administrative assistance to conduct a comprehensive data analysis and review of student performance.

*1. Student Demographics*

Our student population is quite diverse with a wide array of skills, interests, and career goals. The student population ranges from serious Earth Science majors with focused career objectives, to Environmental Studies minors to Science Education majors. The annual number of majors and minors in the Earth Science program ranges from 25 to 40, with over 1500 students tracking through the LACC ES 100 sequence. Over 60% of the ES 100 students are in their freshman or sophomore years, and commonly list their major as "pre-education". Typical enrollment in upper division specialty courses typically ranges from 8-15, with 25 to 60 in more accessible lower division courses (e.g. ES 200 Physical / Historical Geology, ES 331 Oceanography, ES 390 Meteorology). Based on enrollment data from 2002-2005, the Earth Science program supports an average of 37 majors and 13 minors, with a range of 6-12 graduates per year. Demographically, our students are categorically white/Caucasian, 20-24 years of age, with a female-to-male ratio of 1:3.

*2. Post-Baccalaureate Analysis*

As an attempt at preliminary analysis, Dr. Taylor compiled select course data from 1999-2005 (Dr. Taylor upper division class rosters; n = 176), compiled a list of ES program students, and tallied the anecdotal information regarding their post-graduate activities. Of the 176 students compiled, 124 were actively involved in the ES program as majors, minors, or related fields such as Environmental Studies or Education. There is no data available for 59 of the 124 program students (i.e. 48% "no data"); however, some anecdotal post-baccalaureate information exists for the remaining 65. A tally of known student post-program activities follows:

21 = K-12 teaching, 6 = GIS/geospatial technology, 5 = retail sales, 4 = military, 5 = graduate school (3 = geology, 2 = MAT), 3 = geotechnical/construction, 3 = forest resources, 3 = public policy, 2 = hydrologic technician, 1 = river guide, 1 = Peace Corps Volunteer, 1 = registered nurse, 1 = watershed volunteer, 1 = physician's assistant, 1 = emergency medical doctor, 1 = librarian, 1 = law school, 1 = federal forest ranger, 1 = federal customs agent, 1 = federal homeland security, 1 = commercial fisherman, 1 = fire fighter

This preliminary post-baccalaureate analysis of a select subset of ES program students suggests that approximately 3 percent of the declared majors advance on to graduate school in either education or geoscience. Over 20 percent of the same group obtained employment as K-12 teachers, and approximately 12 percent found at least temporary employment in the fields of geospatial technology or natural resources management (GIS, forestry, geotechnical, watershed resources).

**C. MISCELLANEOUS DATA COLLECTION ISSUES[v]:** *Any special issues regarding data collection and instrument design, as well as pertinent timelines, procedures and stakeholders:*

The following issues have been identified as significant road blocks to Earth Science program assessment:
(1) Lack of established institutional culture and infrastructure regarding systematic program assessment,
(2) Lack of systematic institutional reporting guidelines and timeline for annual program assessment,
(3) Lack of administrative support personnel for data collection, data management, instrument design, and statistical analysis,
(4) Lack of adequate faculty time, beyond primary teaching load, to adequately conduct scholarly activity and program assessment tasks,
(5) Lack of institutional funds to support effective and systematic program assessment (e.g. funds to cover nationally standardized exam fees)
(6) Persistent unanswered requests (over the past year) to the WOU Office of Institutional Research, Planning and Assessment for Banner data

**D. ANALYSIS & INTERPRETATION OF EVIDENCE**

No analysis or interpretation has been conducted to systematically assess student outcomes or how well the program meets the stated mission objectives. There is a significant need to develop quantitative assessment metrics that measure student performance over time and how well the Earth Science program meets the stated objectives.

**E. RESULTS AND REPORTS** [vi]

No systematic analysis or assessment reports have been completed. As stated above, there is significant need for WOU to establish systematic reporting guidelines and timelines for annual program assessment. In addition, there is significant need for institutional support, funding, and faculty release time to conduct such comprehensive program assessments.

**F. FOLLOW-UP AND CONTINUOUS IMPROVEMENT: THE FEEDBACK LOOP**[vii]

Systematic program assessment for WOU Earth Science is in the nascent stages. While the program has conducted some preliminary analyses and is working on an exit-exam methodology, much work remains. As stated above, there is significant need for WOU to establish systematic reporting guidelines and timelines for annual program assessment. In addition, there is significant need for institutional support, funding, and faculty release time to conduct such comprehensive program assessments.

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[i] This unit or program mission statement is aligned with and supportive of the University mission as well as the Institutional Aspirations for Learning.

[ii] The following statements describe qualitative and quantitative measurable expectations of what students should be able to know or do when they've completed this program, including student mastery of competencies, skills or tasks. Some or all of these outcomes are also listed in the 2006 WOU catalog. [Whereas a learning outcome is a statement that identifies the skills, knowledge and/or attitude that a learner will be able to demonstrate as a result of successfully completing an identified part of a learning program, a process outcome is the measurable output of the process in place that leads to the learning and unit effectiveness (including such things as service, functionality, work quality, efficiency, satisfaction and compliance [or other key areas related to context, input, process and product].)

[iii] The following systematic, comprehensive and continuous approach has been designed for the program/unit and is intended to provide an accurate picture of how effective the program or unit's actual performance is, including whether student performance matches those expectations and standards identified in the objectives (part II above). [The central question here is whether and to what extent the program is achieving its goals and objectives?] [Assessment of student learning occurs at the program level - e.g. B.A. or B.S., not just at the course level. This means that goals and outcomes have to be at the program level. Ideally, data on assessment of student learning should be collected at several points in the program (e.g., beginning, middle and completion). Unit annual reports shall include a segment on assessment of student learning. The assessment of student learning through multiple and diverse techniques informs programs about the achievements in student learning and provides useful evidence in conducting program self-assessment.]

[iv] Relevant Evidence: The evidence is gathered from multiple sources and is intended to validate/support our understanding of achievements, student learning outcomes, successes and/or failures. [With regard to student learning objectives, methods being used to assess student work and the attainment of outcomes will generally include a rigorous and systematic examination of the following: student portfolios, theses, projects, products, performance tasks and other written work, work samples, paper-based tests, surveys, commercial standardized assessments, student interviews, group projects, observation, concept mapping, observation and dialogue.]

[v] Miscellaneous Data issues: [With regard to evidence and high quality data collection, it may be appropriate to address any unique or unusual aspects of measurement/instrument design as well as the procedures and techniques developed to collect evidence and the timeline for tool development or instrument design] [In implementing the assessment plan, units may rely on quantitative and qualitative methods of assessment; external reviewers; internal reviewers; as well as direct and indirect methods. The key is to identify or develop a quality measure that accurately measures the desired objective. Moreover, it will be helpful to identify any limitations in the measurement technique or instrument design.

For assessment efforts to be reliable and useful for decision making, data should be of the highest quality and tools should be carefully evaluated by the appropriate unit. It will be helpful to pose the following questions:

- Is the measure important? Does it give us meaningful data or is it merely interesting?
- Is the measure and data collected using the measure easily understood? What is being measured and how are data being interpreted?
- Are fluctuations in the measure a result of the department's action and not of someone or something else?
- Does the measure signify achievement of a goal and not just a success of an activity?
- Does this measure provide information which can be used for improvement?]

[vi] Examples include:

**1. Annual Report Assessment Update:** Each program's annual report should have a section dedicated to where they are in their assessment plan, updating the Dean/Provost on all aspects and developments in the Assessment Plan as outlined above. Reports should include a list of assessment tools developed, assessments in progress or completed, results or findings elicited from data collection efforts, studies looking into the reliability and validity of the measures, recommendations based on data, any changes/modifications/decisions made based on findings, and requests for additional resources to implement recommendations.

**2. Final 3-Year Cycle Summative Report and Recommendations:** At the end of the assessment plan cycle, units will submit a final report that addresses the areas specified herein. In addition the final report shall address the results of the assessment process as well as any recommendations and reflections for the future.

**The Results** portion of the final report shall clearly indicate the findings with regard to each stated objective or outcome, clearly indicating therein the degree of success for each outcome (i.e. the extent to which the specific criteria for success were met). The Report shall also include a recommendation section that addresses any areas of potential improvement and concern. The Report shall also indicate how results were used to improve programs with specific illustrations or examples.

**The recommendations** shall address the specific decisions based on each outcome's results and identify areas requiring change or improvement in next assessment cycle.

**Reflections:** This will also be an opportunity to indicate ways to improve the assessment plan process, reflections on the assessment experience as well as next steps toward developing a revised plan as well as any timelines for reevaluation of each outcome (if the outcome is retained) and when each outcome will be assessed again.

[vii] Units shall follow up on Assessment plan recommendations and any identified areas of concern. Follow up action plans should be developed regarding how assessment results will be used to improve the program, department, and/or services. To the extent possible, assessment results shall be communicated to appropriate audiences and relevant stakeholders for feedback and dialogue. The information gathered should be used to inform how further improvements can be made to programs and services. Likewise, the results that highlight key successes and accomplishments should be touted and broadly disseminated to showcase how well we are serving our students.