Earth Science

Mission

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.

Learning Outcomes

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.

Learning Outcomes Assessment: See Assessment Plan at the end of this section

Program Description

The Earth Science program at Western Oregon University offers B.S. and B.A. degrees in Earth Science with minors in Earth Resources, Earth System Science, Geology, and History of Earth and Biosphere. WOU is distinctive in that it offers the only multi-disciplinary Earth Science degree in the Oregon University System. Three tenured faculty members and three fixed-term adjunct faculty members support the program. Focus areas include Earth system science education, volcanology-igneous petrology, sedimentology-paleobiology, and geomorphology-environmental geology-geographic information systems. Supporting curricula includes meteorology, oceanography, geochemistry, and astronomy. Programmatic strengths include: (1) small faculty:student ratios with personalized instruction and a focus on undergraduate training; (2) a curriculum in which Earth Science courses and labs are taught by PhD-trained faculty; (3) degrees leading to student career tracks in science education, natural resource management, and environmental restoration; and (4) a faculty dedicated to scholarly activity that is relevant to training undergraduate students for careers in the 21st century marketplace. The program directly supports the advancement of geoscience education, conservation planning, environmental management, and natural hazards mitigation in the state of Oregon. The problem-solving and technical skills acquired via training in the Earth Sciences are highly valuable and marketable, regardless of career track. Students are expected to actively participate in the learning process and make a significant contribution to the academic integrity of the Earth Science program at WOU. The ultimate goal of the program is to provide graduates with the academic skills that will enable them to be highly competitive in graduate school or the career marketplace.

Key Changes since Last Accreditation Report

The most significant change since the last accreditation report in 1997 is the complete turnover in Geology faculty members. The two previous Geology professors, who retired in 1997 and 1998, were replaced by three new Geology faculty members in 1998 and 1999. The second most important change over the past ten years has been the development and implementation of a new Earth Science Major, which replaced the previous Natural Science Major – Earth Science and Geology options in 2001. The program and course content has been continuously upgraded and reorganized over the past several years (2001-2004) to the current degree structure (refer to Supplemental Materials and Earth Science program web site: www.wou.edu/earthscience). Outcomes of these activities include newly developed courses with an emphasis in faculty specialty areas, elimination of outdated courses, modernization of the LACC ES 104-105-106 sequence, and adoption of a standard "ES" catalog prefix that more accurately reflects the content area associated with the spectrum of courses offered.

Since 1999, the Earth Science program has experienced a paradigm shift away from an Education service program (i.e., primarily supporting the Integrated Science Education major and M.S. in Education) to a liberal arts curriculum and major. This shift towards a liberal arts philosophy was driven in part by the academic training of the tenured faculty and in part by campus-wide changes in student demographics. Since the last accreditation report in 1997, the LACC ES 104-105-106 sequence enrollment has increased from an average of 296 students per term to 478. Concomitantly, the number of M.S. in Education students serviced by Earth Science faculty has declined from 23 students per year to fewer than two students per year. The working hypothesis is that these trends are largely the result of growing demands in the College of Liberal Arts and Science and changes in K-12 teacher preparation requirements as regulated by the Oregon Teacher Standards and Practices Commission.

As part of this paradigm shift towards the liberal arts, we have developed a technology-based curriculum with the addition of courses, internship opportunities, and student research projects. The GeoData Processing Lab and Natural Science student computer lab are direct outgrowths of these activities. In addition, the program has continually worked towards replacing and/or acquiring modern laboratory equipment, which is largely supported by the addition of lab fees and organizational changes within department management.

Role within the University and Relationship to Other Programs

The Earth Science program is part of the Earth and Physical Sciences Department in the Division of Natural Sciences and Mathematics (NSM) at WOU. In addition to the Earth Science major and associated minors, the program supports the Integrated Science Education Major and the Environmental Studies Minor. A major component of the program's work is to manage the high-enrollment liberal arts core curriculum (LACC) laboratory science sequence, Earth System Science (ES 104-105-106). On average, seven to nine lecture sections and 20 to 24 laboratory sections are offered as ES 104-105-106 LACC courses per term. A degree in Earth Science also provides excellent preparation for students entering the Master of Arts in Teaching (MAT) program to earn initial licensure as physical science educators at the middle and high school level.

A key aspect of the program is the close alliance with faculty in physics, chemistry, biology, and education. Faculty members from different disciplines work directly together on a daily basis and cultivate a multi-disciplinary, collegial atmosphere that is unique compared to other institutions. The cross-disciplinary alliance in NSM provides a superb opportunity for faculty and students with diverse interests to interact in a rich and stimulating academic environment. Earth Science plays an

important role by providing a nexus for studies in the biological and physical sciences. In this regard, Earth Science faculty are instrumental in supporting the Environmental Science Institute (ESI) at WOU, a growing alliance of NSM faculty and programs that provides integrated, interdisciplinary field-based courses and research opportunities in Natural Science disciplines. ESI is working closely with the Division of Extended Programs to provide curricula and continuing education opportunities for pre-service education students, continuing education professionals, discipline-specific science majors, and interested community members. In addition, there is a common linkage between majors and minors in Earth Science, Geography, and Environmental Studies. As such, a significant number of students share common classes in each of these programs.

Faculty and Staff

Associate Professors: Jeffrey Myers, Stephen Taylor, and Jeffrey Templeton

Three full-time tenured faculty members and three fixed-term adjuncts support the Earth Science program. The core curriculum in the Earth Science degree track is based on the discipline specialties of the three tenured faculty members: (1) Surface Processes – Environmental – Applied Geographic Information Systems (Dr. Taylor), (2) Volcanology - Petrology – Geochemistry (Dr. Templeton), and (3) Stratigraphy - Sedimentology – Paleobiology (Dr. Myers). The LACC Earth System Science sequence (ES 104-105-106) uses a pedagogy in which concepts of chemistry, physics, and geology are presented in a real-world context of the Earth as an integrated system. As such, the three fixed-term adjuncts that teach these courses possess degrees and/or extensive background in Earth Science. The Earth Science program also receives ancillary faculty support in the form of elective courses from Physics, Biology, and Chemistry.

Of the six tenured and adjunct faculty members serving the Earth Science program, five are Caucasian males, and one is a Caucasian female. Adjuncts work part-time to full-time, dependent upon course enrollments and staffing needs. A full-time teaching load for tenured faculty is 12 credit hours per term, while that of the adjuncts is 15. The sole duty of fixed-term faculty is that of teaching and course management. Tenured faculty duties include teaching, discipline-specific scholarly activity, and service to the university, community, and profession. Of the three task areas, teaching occupies approximately 70% of the work load, followed by service and scholarship in decreasing order of time commitment. Regardless of the high teaching load, Earth Science faculty members are actively engaged in research, professional development, and outreach. Refer to curriculum vitas in the supplemental materials section and the program Web site

Students

The Earth Science student population is quite diverse in terms of skills, interests, and career goals, ranging from Earth Science majors with focused career objectives to Environmental Studies minors and Integrated Science Education majors. The annual number of majors and minors in the Earth Science program ranges from 25 to 40, with nearly 1500 students tracking through the LACC ES 104-105-106 sequence. Most ES 100 students are in their freshman or sophomore years, and over 60% list their major as "pre-education". Enrollment in upper-division specialty courses ranges from 8-15, with 25 to 60 in more accessible lower and upper division courses (e.g., ES 201-202-203 Principles of Geology, ES 331 Oceanography, and 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 predominantly white/Caucasian, 20-24 years of age, with a female-to-male ratio of 1:3. Preliminary

analysis of select course data from 1999-2005 (Dr. Taylor upper-division class rosters; n = 176) indicates that approximately 75% of our upper-division students are declared Earth Science majors and minors. The remaining 25% are working on graduate education degrees, free electives, and ancillary minors such as Environmental Studies. Approximately 3% of the declared majors advance on to graduate school in either education or geoscience. Over 20% of the same group obtained employment as K-12 teachers, and approximately 12% found at least temporary employment in the fields of geospatial technology or natural resources management (GIS, forestry, geotechnical, watershed management).

Number of Majors, Minors, and Graduates by Academic Year

Academic Year	Majors#	Minors*	Graduates#
2002-03	37	10	7
2003-04	37	13	6
2004-05	38	14	6
2005-06	35	20	6

#Includes Earth Science and Natural Science-Geology and Earth Science Options.

*Includes Earth Resources, Earth System Science, Environmental Studies, Geology, and History of Earth and Biosphere.

Examples of Outstanding Student Graduates for the Past Five Years

The following WOU alumni rank in the top 5% of all graduating Earth Science majors over the past five years (listed in reverse chronological order):

Rachel Pirot (B.S. Earth Science, 2006): Currently working on an MS degree in Geology at Portland State University. Rachel's thesis research involves geotechnical analysis and landslide assessment in western Oregon.

Jeff Budnick (B.S. Earth Science, 2005): Currently employed as a geospatial technology specialist by Sanders & Associates, Portland, Oregon. Jeff also has experience working as a field hydrologist at Andrews Experimental Forest and a Geotechnical Analyst for a Portland engineering firm.

Sheila Alfsen (B.S. Earth Science, 2004; M.A. Teaching, 2006): Currently employed as Science teacher at Amity High School in Amity, Oregon. Sheila is also registered as a professional Geologist-in-Training (GIT) in the state of Oregon. She double-majored in Spanish and is actively working to promote geoscience literacy in migrant Hispanic youth.

Tammy Baker (B.S. Earth Science, 2003): Currently employed as a Geographic Information Systems (GIS) specialist at the Oregon Department of Forestry, Salem, Oregon. Tammy also worked as a GIS technician for Geolsolv, Inc., Tangent, Oregon.

Denise Giles (B.S. Earth Science, 2003): Currently working on a PhD in Geology at Oregon State University. Denise's dissertation research involves isotopic analysis of the Aucanquilcha volcanic cluster in northern Chile.

Julie Utley (B.S. Earth Science, 2002): Earned an M.S. degree in Geological Engineering from the University of Nevada-Reno. She worked as a project engineer for Golder Associates in Alaska and Texas. Julie was recently hired as a physical science teacher at Klein High School in Houston, Texas.

Resources (Facilities, Technology, Budgets)

Facilities

The Earth Science program still lags behind other science program areas in terms of modern laboratory equipment and related infrastructure. Current needs include student-grade laboratory petrographic microscopes, student-grade reflected-light binocular microscopes, field-grade laptops and high resolution GPS station for field mapping and data collection, laboratory remodeling / construction upgrades, and a digital imaging analysis system for the geo-data processing lab.

Technology

The technologic hub of the Earth Science program is the Geo-Data Processing Laboratory in rooms 218A and 216A of the Natural Sciences Building. The lab currently supports ten PC-workstations, color and laser print stations, a large-format (36 inch) color plotter, a set of digitizing tablets, digital image scanners, and a collection of advanced geoprocessing-GIS software and databases (e.g., ArcGIS, IDRISI image processing, surfer/grapher, rockware, groundwater-river modeling tools, state digital map and photo data). The lab is used for student support of upper-division courses, for faculty-student research, and for community development projects. Examples of the latter include compilation of spatial datasets for the Luckiamute Watershed Council, the Pudding River Watershed Council, and the City of Independence (Ash Creek Recreation Project). The GIS software initiative in the Earth Science program also served as the catalyst for a campus-wide deployment involving University Computing Services, the Student Technology Fee Committee, and the College of Education. The technology and quantitative skills developed by students in the GeoData Lab have resulted in modest success with job placement; at least six graduates have found employment as GIS specialists for private and government organizations. Information management specialists are currently in high demand in both government and industry. The need for well-trained technology specialists with a broad-based science background is expected to grow throughout the coming decades.

The Earth Science program, along with the Division of Natural Sciences and Mathematics, has greatly expanded its technology capacity in the past six years. Technology-based resources that have resulted from these efforts include NS 101 multi-media presentation technology, NS 017 electronic data instrumentation, updated PC workstations (n ~ 18), software resources, surveying technology, petrographic microscopes, digital imaging systems, and mobile multi-media presentation carts. Funds for this expansion were derived from internal supplies and services budgets, student lab and technology fees, and external grant funding (e.g., National Science Foundation, and U.S. Dept. of Education).

SWOT Overview & the Future

Primary Strengths

1. The Earth Science program has a faculty:student ratio that is conducive to one-on-one contact, personalized instruction, and promotion of undergraduate research.
2. The Earth Science program offers an introductory LACC laboratory science sequence (ES 104-105-106) that is highly relevant to real-world problem solving and appealing to non-science majors.
3. Earth Science faculty members embrace a technology-based curriculum and are working to implement standardized program assessment tools.
4. Earth Science faculty members actively serve as leaders on a number of campus-wide committees and actively serve in a variety of professional capacities.
5. Earth Science faculty members are actively engaged in a wide spectrum of peer-reviewed research, publications, and related professional development.

Primary Challenges

The four primary challenges to advancing the Earth Science program at WOU include: (1) over-dependence on adjunct faculty and lack of tenure-line positions, (2) limited faculty time available for scholarly activities, program assessment, and faculty development, (3) paucity of internal funding for large-scale equipment and facility infrastructure, and (4) student enrollment and retention.

1. The Earth Science program is currently in need of at least one tenure-track faculty position. There is an ongoing issue with regards to staffing the Earth System Science sequence (ES 104, 105, 106) lecture and laboratory courses primarily with adjunct instructors. For example, of the total 2003-2004 adjunct budget for the Division of Natural Sciences and Math ($326,554), 25.2% (2.2 FTE) was allotted to Math, 18.5% (1.6 FTE) was allotted to Biology, and 56.3% (5.0 FTE) was allotted to Earth and Physical Sciences (EPS). Of the 5.0 FTE adjunct load in EPS, 0.2 FTE is allotted to Physics, 0.6 FTE is allotted to Chemistry, and 4.2 FTE was allotted to Earth Science-related courses (Meteorology, Earth System Science-GS, and Ed. Methods). Since the last accreditation in 1997, the adjunct faculty ratio in the Earth Science program has ranged from 50-60%, comparable to the university-wide adjunct-tenure ratio. The program course load is supported with an anomalously high number of adjunct instructors. Adjunct pay levels, teaching loads, and contract procedures at WOU are such that there is relatively high turnover in these positions, which ultimately destabilizes curricular programs and inhibits long-term development. Institutional stability, continuity, and future growth are dependent upon the stock of tenure-line faculty. Adjuncts represent short term investments with high turnover rate and curricular instability. The Earth Science program, and university as a whole, is challenged by this instability.
2. An ongoing challenge is associated with the teaching load required of faculty. The standard teaching assignment requires 12 contact hours per week (36 FTE contact hours per academic year), with lecture hours counting for 1 FTE contact and lab hours counting for 0.66. The teaching load combined with maximum-capacity class sizes results in little time available for other faculty duties such as scholarly research, program planning / assessment, and professional service. As such, the bulk of the latter activities must be conducted after hours, on weekends, and during the summer. An additional challenge presented by the relatively high teaching load is that associated with depletion of creative energy and "teacher burnout".
3. While we have worked diligently to upgrade and support laboratory infrastructure, the Earth Science program still lags behind other science program areas in terms of modern laboratory equipment and resources. Existing infrastructure needs include student-grade laboratory

petrographic microscopes, student-grade reflected-light binocular microscopes, field-grade laptops and high resolution GPS station for field mapping and data collection, laboratory remodeling / construction upgrades, and a digital imaging analysis system for the geo-data processing lab.

4. Student enrollment and retention is an ongoing challenge at all levels of the University, including the Earth Science program. Earth Science course enrollments and numbers of majors have been relatively steady since the last accreditation, but growth has been slower than expected. These enrollment trends in large part mirror that of the university as a whole. The most significant challenge to growth of the Earth Science program results from the general lack of geology/Earth Science in the high school curriculum at the state level. In the state of Oregon, K-12 Students are only required to take Earth Science in 8th grade. Geology-related course offerings at the high school level occur sporadically on a district-by-district (teacher to teacher) basis, and are not prominently required in the same way as chemistry, biology, or physics. The net result is that students receive minimal exposure to Earth Science or Geology in high school, with little understanding of career options or the importance of Earth Science to natural resources issues in the state of Oregon.

Challenges: Action Plan for Initiating Change

Challenge 1 - Adjunct Faculty and Tenure-Track Positions: To address the first challenge, we have requested that the administration hire at least two more tenure-track faculty, including an Earth and Physical Science Education Specialist and a broadly trained Physical Scientist with a background in Earth Science and Physics. We have also requested that the administration provide extended 1- to 2-year contracts for adjuncts to promote commitment, reduce staff turnover, and create stability in the curriculum.

Challenge 2 – Teaching Load: To address the second challenge, we are working with the local faculty union representative (American Federation of Teachers at WOU) and WOU administration to reduce the annual FTE credit hours to 33 and to initiate a 1:1 accounting system for contact hours in laboratory classes. This initiative extends beyond the immediate Earth Science Program to the entire Division of Natural Sciences and Mathematics. While some modest gains in this regard have been achieved in the past, they are subject to renegotiation every two years according to collective bargaining procedures. What little ground had been gained for reduced teaching loads in the past was recently lost during the last contract negotiation. This is a challenge that requires institutional commitment and a long-term administrative investment of funding and faculty positions.

Challenge 3 – Funding for Facility Infrastructure: To address the third challenge, we have been actively involved in securing external grants and student lab fees to support laboratory infrastructure improvements. While great progress has been achieved during the past five years, the bulk of funds to build laboratory infrastructure came from one-time contributions via in-house grants and administrative support (e.g., PT3, Dean's Office, Student Technology Fee, OCEPT). This has been a slow and tedious process that requires constant faculty attention and time. Although the laboratory infrastructure is sporadically advancing, a systematic, sustainable investment strategy is needed to support upgrades. This is a significant challenge that requires institutional commitment, long-term administrative investment, a secured budget line-item, WOU Foundation support, and teaching release time for faculty to develop externally-funded grants.

Challenge 4 – Student Recruitment and Retention: To address the fourth challenge, Earth Science faculty members have been engaged in a wide variety of on-campus recruiting activities over the past seven years. These include participation in career-day events, preview day displays, advertising and signage, science fair participation, and career counseling. While these efforts have been persistent, the relatively flat enrollment trends in Earth Science may require a more targeted approach to recruiting and advertising. The primary road block to recruiting is the general lack of exposure to Geology / Earth Science curricula and career opportunities at the high school level. This road block represents a systemic challenge that exists at the state level and is very difficult to address at the local program level. A significant percentage of students who are attracted to the Earth Science major are recruited from the ranks of lower division undergraduates who enroll in 100- and 200-level LACC courses. As such, our current recruitment strategy is to focus on information exchange and awareness in the introductory courses. The LACC students represent a select population of freshman and sophomores who are already in residence at WOU, many of whom are still searching for majors and career tracks. Recruiting efforts in the near future will emphasize outreach at the ES100- and ES200-level students.

Looking Ahead to the Future

The Earth Science program at WOU is built on a solid foundation consisting of dedicated faculty at relatively early stages in their careers and a newly reorganized major that is designed to prepare students for the 21st century marketplace. The next phase of program development will focus on adding tenure-line faculty, expanding laboratory and technology infrastructure, strengthening course enrollments, and expansion of an experiential-based (i.e. research / community service) learning model. As outlined in the college-wide strategic plan of 2004 (www.wou.edu/las/physci/geology/esci_strategic_plan.pdf), our five-year strategy for program advancement includes the following action items:

- Hiring a tenure-track physical science education specialist, with cross-over linkages to Earth system science and physics.
- Continued grant writing with a focus on Earth Science curriculum development, research initiatives, and infrastructure improvement.
- Further development of service learning, internship, and professional outreach projects (e.g., outreach to Luckiamute Watershed Council, coordination of Oregon Junior Academy-JSHS-ISEF science fairs).
- Further development of faculty-student research opportunities; ultimately adopting a senior-thesis option based on best practices established by the Council on Undergraduate Research (CUR).
- Further expansion of interdisciplinary program linkages via the Environmental Science Institute and Division of Natural Sciences and Mathematics.
- Continue to develop individual course projects that emphasize field experiences, multimedia presentation, content interpretation, and technology-based problem solving.
- Redefine and reinvigorate linkages between WOU Earth Science and the K-12 teacher preparation programs.
- Develop sustainable student recruiting strategies with a focus on the introductory LACC

Earth Science courses.

- Increase number of Earth Science majors by 15%; increase and stabilize average enrollment in upper division courses to 12; graduate 5-10 majors per year, with an average of 8.
- Continue to develop and implement the use of Senior Seminar (ES 407) as the capstone course for the Earth Science major.
- Adopt the Association of State Boards of Geologists (ASBOG) fundamentals exam as a standardized assessment tool for graduating seniors.

Unit Assessment Plan

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

I. Statement of unit mission:

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:

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

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.

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

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 (post-baccalaureate data are available on the Earth Science program web site).

B. RELEVANT QUANTITATIVE AND/OR QUALITATIVE EVIDENCE:

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: *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

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

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.

List of Supplemental Materials

(Available at the Earth Science program web site: www.wou.edu/earthscience)

- Earth Science Program Overview (2006)

  www.wou.edu/las/physci/geology/esci_prog_files/frame.htm
- Earth Science Degree Programs and Minors

  www.wou.edu/las/physci/geology/degree_programs.htm
- Earth Science Course Descriptions

  www.wou.edu/las/physci/geology/geocourses.pdf
- Earth Science Strategic Plan Worksheet (2004)

  www.wou.edu/las/physci/geology/esci_strategic_plan.pdf
- Draft of Earth Science Program Review (4/26/06)

  www.wou.edu/las/physci/geology/esci_strategic_plan.pdf
- Draft of Earth Science Assessment Plan (11/15/06)

  www.wou.edu/las/physci/geology/esci_strategic_plan.pdf
- Student Assessment Methodology

  www.wou.edu/las/physci/geology/esci_assessment.pdf
- Student Demographics

  www.wou.edu/las/physci/geology/esci_demographics.pdf
- Expanded List of Learning Outcomes