AY17 LRES Undergraduate Program Assessment Report – May 12, 2017

LRES is in the process of developing a formal Undergraduate Learning Outcomes Assessment Protocol to improve (formatively) both student performance as well as contribute to broader MSU institutional benchmarks. Over the last year, we have defined our desired Learning Outcomes and have made significant progress in developing a path forward for evaluating them. We are in the process of developing a faculty-driven, improvement-motivated, and evidence-based system for quantitative assessment of teaching success. Key challenges include developing a strategy that is objective and that provides actionable feedback on teaching effectiveness at annual timesteps. Critical to the sustained success of this endeavor is that the faculty ultimately find the process *meaningful* and *valuable* in reaching our departmental goals. This will require a clear articulation of how results from our departmental assessments feedback to inform and direct future departmental efforts, including future iterations of the assessment protocol itself.

LRES Undergraduate Learning Outcomes

Our department offers an Environmental Science undergraduate degree with five options: Environmental Sciences, Environmental Biology, Geospatial & Environmental Analysis, Land Rehabilitation, and Soil & Water Sciences. Across all five of these options, our graduates are expected to demonstrate measurable improvements across the following five Undergraduate Learning Outcomes (ULO). Discussion in AY 17 included combining our eight outcomes into five outcomes. Our graduates will:

1. An understanding of core theoretical principles and applications in evolutionary, ecological and physical environmental sciences.

2. Ability to access, read, and critically assess the quality and source of environmental information.

3. Knowledge of the theory and practice of data analysis in environmental sciences, including statistical analysis, model building, and graphical presentation of data.

4. The ability to write and present scientific material effectively.

5. An understanding of the ethical implications of conducting and applying environmental science.

LRES Learning Outcome Assessment Plan

Over a three-year cycle each of the Learning Outcomes will be assessed:

Outcome	Cycle One	Cycle Two
1	2017-18	2019-20
2	2018-19	2020-21
3	2018-19	2020-21
4	2018-19	2020-21
5	2017-18	2019-21

During Fall term of each academic year (AY) the LRES Outcomes Assessment committee works with the entire LRES faculty to identify specific assignments in courses that can be used to demonstrate student proficiency related to each outcome to be assessed that academic year. Samples of student work on identified assignments were collected for assessment by the LRES Outcomes Assessment committee. We will use the following Rubric:

LRES Assessment Rubric Template

Scoring Rubric

Course: _____ Semester: Spring XX_____
Evaluator: _____

Learning Activities Assessed: ***Indicate which of the following activities is being used for the Assessment***

Written Examination _____
Written Assignment _____
In Class activities _____
Lab procedure _____
Presentation _____
Other (*specify*) _____

Learning Outcome Assessed (1-5): _____

Learning Objectives:	**Performance level**				
To what extent does the student response indicate and understanding of:					
a. Learning element "a"	NA	1	2	3	4
b. Learning element "b"	NA	1	2	3	4
c. Learning element "c"	NA	1	2	3	4
d. Learning element "d"	NA	1	2	3	4
e. Learning element "e"	NA	1	2	3	4

NA= not done, not applicable
1 = Inadequate and unacceptable performance
*2 = Performed but with poor execution—***threshold level***
3 = Adequate performance; Met expectations
4 = Performance well-executed; Exceeds expectation

****threshold level:*** if student performance falls below this threshold faculty action will be taken to improve performance

Use of Assessment Results

The results of the assessment will be presented to the LRES faculty annually. Any curriculum changes needed to improve student proficiency on a Learning Outcome will be implemented the following year. We subscribe to the bidirectional value of integrating assessment into the curriculum to improve both student and institutional performance (NILOA 2016).

AY 2017 Assessment - In academic year 2017, we assessed Outcomes 1 and 5 by evaluating the responses of LRES Majors to specific questions on in-class exams in Spring courses "Ecosystem Biogeochemistry and Global Change" (ENSC 468; Brookshire) and "Soil Remediation" (ENSC 460; Hartshorn), respectively.

Assessment of LRES ULO #1:

Course: _____ENSC 468_____ Semester: Spring 17_____
Evaluator: _____Brookshire & Currey_____

Learning Activities Assessed: ***Indicate which of the following activities is being used for the Assessment***

Written Examination ____1____
Written Assignment _____
In Class activities _____
Lab procedure _____
Presentation _____
Other (*specify*) _____

Learning Outcome Assessed (1-5): _____1_____

Learning Objectives:	**Performance level**				
To what extent does the student response indicate and understanding of:					
a. Natural selection	NA	1	2	3	4
b. Ecological interactions	NA	1	2	3	4
c. Mass conservation and flow	NA	1	2	3	4
d. Quantitative reasoning	NA	1	2	3	4
e. Conceptual synthesis	NA	1	2	3	4

Approach: Two questions from the midterm that specifically addressed ULO #1 were chosen for assessment. Scans were made of all LRES Major responses and two independent evaluators each randomly selected 5 anonymous student responses to the following questions:

Question 1) Provide an explanation or a mathematical expression for each of the following (show units):

Mean turnover **rate** and **time** (i.e., residence time) for steady state soil C pool of 200 g m^{-2} and input C flux of 20 g m^{-2} yr^{-1}

Average score =3.3

Question 2) Assume that a novel strain of decomposer bacteria suddenly evolves in a temperate forest in a high N-deposition area of Europe or N. America. These bacteria can decompose leaf litter in a manner identical to other leaf decomposers, and differ only in one way: the novel bacteria have a biomass C: N ratio of 50:1 (rather than the typical 5:1 ratio). Remembering typical yield coefficients for bacteria (~0.5) and C: N ratios of detritus (~60:1), are these bacteria likely to spread in temperate forest soils? If so, what effect do you expect them to have on forest N and C cycling? Show calculations.

Average score =2.7

Thus, the grand mean (*n=10*) for our assessment of ULO #1 was **2.9 out of 4.0.** According to this score, our majors are marginally **meeting expectations** in their *understanding of core theoretical principles and applications in evolutionary, ecological and physical environmental sciences*.

Assessment of LRES ULO #5:

The LRES Outcomes Assessment Committee supports the inclusion of "understanding of the ethical implications of conducting and applying environmental science" as an ULO. This Committee supports the notion that institutions such as Montana State University, and by extension, all our LRES faculty, should broaden student understanding of the ethical implications of the conduct and application of their discipline. This is because, in part, educational organizations have responsibility for the (future) behavior of students.

Within our department, and as part of our departmental efforts to align assessment with departmental outcomes, faculty self-reported nine courses addressing ULO#5 at a 'developing' level (BIOE422, "Insect ecology," R. Peterson; ENSC407, "Risk assessment," R. Peterson; ENSC410, "Biodiversity methods," L. Rew; ENSC443, "Weed ecology," B. Maxwell; ENSC454, "Landscape pedology," S. Ewing; ENSC460, "Soil remediation," T. Hartshorn; ENSC461, "Restoration ecology," C. Zabinski; ENSC468, "Biogeochemistry," J. Brookshire; and ENSC499, "Capstone," C. Zabinski), and four courses at an 'introductory' level (BIOM452, "Soil and environmental microbiology," T. McDermott; ENSC245, "Soils," T. Hartshorn; ENSC444, "Hydrology," R. Payn; and ENSC465, "Environmental biophysics," P. Stoy).

A 2002 National Academies report (Rubenstein et al. 2002: "Integrity in scientific research: Creating an environment that promotes responsible conduct") noted:

> *There is a growing belief that organizations are social actors responsible for the ethical or unethical behaviors of their employees. In fact, corporations (Bowen and Power, 1993) have been held responsible under the law for acts of malfeasance and misfeasance engaged in by employees, sometimes even when the acts of those employees were beyond the scope of their employment. Such instances prompted scholars in the field of organizational development to turn their attention to the assessment of moral climate and to an analysis of the effects of moral climate on decision making.*

In the preparation of this assessment of ULO#5, this Committee relied heavily on a specific appendix (B: "Outcome measures for assessing integrity in the research environment") to that 2002 report. For example, that document highlights the potential value of the Defining Issues Test (DIT), originally developed by James Rest in the 1970s. This test has been used to quantify reasoning strategies "that an individual uses when confronted with complex moral problems." Three main indices as well as two information-processing can be derived: the P index is "the proportion of times that respondents select arguments that appeal to moral ideals"; the PI index is "the proportion of times that respondents select arguments that appeal to personal interests"; and the MN index is "the proportion of times that respondents select arguments that appeal to maintaining norms"; the U index, by contrast, defines the degree of consistency between reasoning and judgment; while the N2 index "takes into account how well the respondent discriminates among the various arguments."

Approach: To assess whether students in an upper-level LRES undergraduate course met ULO#5, all 32 students in "Soil remediation" (ENSC460) were provided with the following prompt as part of a problem set (Q5.7): "Our modern rush to decarbonize energy sources… neglects the reality that none of these technologies can develop without increased access to up to 60 critical metals (sensu Graedel et al. 2015) that must be mined from ore bodies, somewhere. Frame an ethical argument for the opening of a mine in a local area you are familiar with—to support global demand for an earth-derived resource. 200 word max."

Of the 32 students, only 24 completed the assignment (unfortunately, many students opted to not complete the assignment since the problem set with the lowest score was dropped from their final course score). Of these, 23 were evaluated using a three-part, 1-through-4-item rubric (modified from Peirce 2006).

LRES Assessment Form
Scoring Rubric

Course: _ENSC460_____
Semester:_Spring 2017_____
Evaluator: _Tony Hartshorn_____

Learning Activities Assessed:
Written Assignment _X_____

Learning Outcome Assessed (1-5): #5 (Ethics)_____

Objectives evaluated
#1 Conservation of mass (4.6a,b,d)
#5 Ethics of data gestational age (PFOA, 4.6f)
#5 Ethics of 'can't have it all' (5.6)
#5 Ethics of #metalmiles to decarbonize (5.7)

The rubric used is pasted below with scoring below the colored boxes:

Knowledge & comprehension ("basics")				Application & analysis ("attainment")				Beyond the book report ("synthesis")					
1-- The work demonstrates an inadequate understanding of the relevant facts / data / theories / terms as well as a limited ability to organize the information for further assessment.	2-- The work demonstrates an uneven and shaky understanding of the relevant facts / data / theories / terms as well as a limited ability to organize the information for further assessment.	3--The work demonstrates an adequate understanding of the relevant facts / data / theories / terms as well as the ability to organize the information for further assessment.	4—The work consistently demonstrates clear, accurate, detailed and comprehensive understanding of the relevant facts / data / theories / terms as well as the ability to organize the information for further assessment.	1-- The work demonstrates extremely limited ability to work with the key concepts / information / process / theory -- applying or extending them with very limited success to new problems or contexts, making predictions, drawing inferences, analyzing patterns and component parts, communicating insightful contrasts and comparisons.	2-- The work demonstrates uneven and shaky ability to work with the key concepts / information / process / theory -- applying or extending them with mixed success to new problems or contexts, making predictions, drawing inferences, analyzing patterns and component parts, communicating insightful contrasts and comparisons.	3--The work demonstrates adequate ability to work with the key concepts / information / process / theory -- applying or extending them to a variety of new problems or contexts, making predictions, drawing inferences, analyzing patterns and component parts, communicating insightful contrasts and comparisons.	4—The work demonstrates confident ability to work with the key concepts / information / process / theory -- applying or extending them to a wide variety of new problems or contexts, making predictions, drawing inferences, analyzing patterns and component parts, communicating insightful contrasts and comparisons.	1-- The work demonstrates little ability to take ideas / theories / processes / principles further into new territory, broader generalizations, and implications – as well as a limited and superficial ability to assess discriminatively the value, credibility and power of these ideas to frame well-considered opinions.	2-- The work demonstrates uneven and superficial ability to take ideas / theories / processes / principles further into new territory, broader generalizations, and implications – as well as a limited ability to assess discriminatively the value, credibility and power of these ideas to frame well-considered opinions.	3-- The work demonstrates adequate ability to take ideas / theories / processes / principles further into new territory, broader generalizations, and implications – as well as to assess discriminatively the value, credibility and power of these ideas to frame well-considered opinions.	4—The work demonstrates surprising/insightful ability to take ideas / theories / processes / principles further into new territory, broader generalizations, and implications – as well as to assess discriminatively the value, credibility and power of these ideas to frame well-considered opinions.		notes
		3			3				2			8	
		2			2				2			6	
												6.5	6.0
												1.4	1.5
												23	

Our average LRES student scored a 6.0±1.5 (mean±1SD, *n*=12), out of a total possible of 12 points (4 maximum per rubric component: knowledge and comprehension; application and analysis; and "beyond the book report"). This 50% score is only slightly lower than the class as a whole (n=23), which included numerous non-LRES (engineering) students.

Translated to our 4-part, overall departmental rubric (NA and 1-4), the **average score was a 2** (mean 6 divided by the 3 sub-rubric component scores), implying "**performed but with poor execution**." In other words, this assessment would imply that our students, if they obtain an improved understanding of the ethical implications of the conduct and application of environmental science across their undergraduate major at MSU, likely only experienced the most modest of improvements.

Additional resources:

1 https://www.insidehighered.com/blogs/stratedgy/teaching-ethics

2 2013 Gardner, J. The public understanding of error in educational assessment **DOI:** 10.1080/03054985.2012.760290

3 http://digitalcommons.georgiasouthern.edu/cgi/viewcontent.cgi?article=1078&context=ij-sotl

4 https://www.geneticliteracyproject.org/2014/06/24/scientists-react-to-republished-seralini-maize-rat-study/

5 https://enveurope.springeropen.com/articles/10.1186/s12302-014-0014-5

6 potentially useful eportfolio materials http://learningoutcomesassessment.org/documents/AlternativesforAssessment.pdf

7 https://books.google.com/books?hl=en&lr=&id=vXhhAAAAQBAJ&oi=fnd&pg=PP1&dq=ethics+versus+morals&ots=FpebyaVO3v&sig=-nDi1JgroXJZmCVgPqTO7_B1ocY#v=onepage&q&f=false

8 step by step guide to effective survey development (maybe) http://njaes.rutgers.edu/pubs/fs995/

9 Haverkamp J, Vogt M. Beyond academic evidence: innovative uses of technology within e-portfolios to achieve learner centered outcomes in a DNP Program. J Prof Nurs. 2015;31(4):284-289. From https://www.ohio.edu/chsp/documents/upload/2016-CHSP-Faculty-Research-Portfolio-15sep16-final-post.pdf

10 Peirce 2006 http://academic.pg.cc.md.us/~wpeirce/MCCCTR/Designingrubricsassessingthinking.html