Assessment Report for Academic Year 2020-2021
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Program: Masters of Science in Environmental Management (MSEM) Program: Graduate Degree

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MSEM Mission Statement

The Environmental Management Program will educate graduate students to provide management solutions to environmental problems using innovative, interdisciplinary approaches in an environmentally just manner.

There have been no changes to the Mission Statement since the last report.

PLOs

1. Demonstrate an interdisciplinary approach in analysis of environmental issues and management strategies.
2. Utilize both theory and applied knowledge to evaluate and recommend management strategies for environmental issues.
3. Choose and apply appropriate tools, techniques, and (or) technologies to analyze environmental issues.
4. Skillfully communicate environmental management issues through written reports, oral, and visual presentations.

There have been no changes to the PLOs since the last report.

Curricular Map

The curricular map for the MSEM Program, showing the extent to which the learning outcomes are covered in each course, is shown in Table 1. The focus of this year's assessment is using the Research Methods course (ENVM 690) to evaluate PLO 3 (highlighted in yellow).

Table 1. Curricular Map for MSEM Program. I = Introduced, D = Developed, M = Mastered.

Learning outcomes/Course	Demonstrate an interdisciplinary approach in analysis of environmental issues and management strategies.	Utilize both theory and applied knowledge to evaluate and recommend management strategies for environmental issues.	Choose and apply appropriate tools, techniques, and technologies to analyze environmental issues.	Skillfully communicate environmental management issues through written reports, oral, and visual presentations.
Aquatic Pollution	M	M	I	M
Climate Change Mit.	D-M	D-M	D	D
Data Analysis	M	M	M	M
Ecology	I	I,D	I	I
Energy Auditing	NA	NA	D	D
Env.Eng. I + II	N/A	N/A	D	D
Environmental Chemistry	N/A	I/D	I	D
Env Economics	N/A	I	D	N/A
Environmental Health	M	D	I	D
Environmental Policy	D-M	D	I	D
Env Toxicology	M	D	D	D
Field Survey Management	I	I	D	M
GO Remediation	D	D	D	D
Hazardous Waste Mgt.	I	I	D	I
Marine Resources	D	M	I	M
Master's Project ENVM 698	M	M	M	M
Natural Resource Ec.	N/A	D	D	N/A
Quantitative Methods	N/A	N/A	D	I
Research Methods	M	D	M	D
Risk Management	D	D	D	D
Risk Assessment	M	D	D	N/A
Risk Management* AK	M	M	D	M
Stream + Riparian Eco.	D	D	D	D
Sustainability Leadership	D	D	D	D
Sustainability: The Future	D	D	D	D
Sustainable Building	D	D	D	D
Sustainable Design	M	M	D	M
Urban Resilience	D-M	D-M	D	D
Water in Env Management	I	I	D	D

Water Treatment	D	D	D	D
Wildlife Conservation	I, D	D	D	D

There have been no changes to the Curricular Map since the last report.

Assessment Schedule

The most recent Academic Program Review for the ENVS Department and the MSEM Program was in spring 2018. Table 2 shows a list of past assessments and plans for future MSEM assessments.

Table 2. Assessment schedule for MSEM Program since 2017 Academic Program Review.

Academic year	**PLOs reviewed**
2015-2017	PLO 4: using Master's Project Presentations
2016-2017	PLO 2: using Master's Projects
2017-2018	Skipped this report, with permission, due to lack of a consistent GPD
2018-2019	PLO 3: using 3 introductory required courses
2019-2020	PLO 4: using Master's Project presentations
2020-2021	PLO 3: using Research Methods
2021-2022	PLO 1 proposed for review
2022-2023	PLO 2 proposed for review
2023-2024	PLO 4 proposed for review

Methodology

This year we assessed PLO 3 (*Choose and apply appropriate tools, techniques, and (or) technologies to analyze environmental issues*) using an evaluation of the final assignment submitted in three sections of ENVM 690 Research Methods that were taught in Fall 2020. This class prepares students for their Master's Project, and the final project is an overview of the proposed research for the Master's Project, including:

- a statement of research questions,
- a literature synthesis highlighting current knowledge, and
- a summary of proposed research methods.

We reviewed the final proposals for all 24 students from three sections of Research Methods from Fall 2020. We completed duplicate assessments of the 24 students, for a total of 48 assessments (4 faculty with 12 assessments per faculty member that were randomly assigned). Assessments were based on the rubric in Table 3 that incorporates five criteria covering different

aspects of PLO 3. We calibrated our reviews with an initial review of two proposals by all four faculty. We discussed our initial assessments of these two proposals, and clarified scoring as well as details in the rubric to calibrate and simplify scoring of the 24 proposals.

Total scores were summed across all five criteria (maximum score = 15). We calculated the average for the total score and the five individual criteria scores. We also evaluated differences in assessments by individual faculty members by calculating the difference in scores for the duplicate evaluations of individual students by two faculty members.

Table 3. Rubric for PLO 3 using the final proposal from Research Methods.

Criteria	**Exceptional (3)**	**Proficient (2)**	**Approaching Proficient (1)**	**Below Proficient (0)**
clear framing of research question(s) to guide realistic and relevant management decisions	unique and relevant research question that is focused and likely to lead to valuable synthesis and management recommendations	solid research question that is likely to provide some management recommendations	good approach for the research question but some concerns about the focus and/or the relevance to management recommendations	vague research question that may not be easily investigated or evaluated
appropriate collection of relevant references that reflects the use of literature searching tools	outstanding resources both in terms of number and quality proper citations and references are always provided	incorporation of at least 7 peer-reviewed articles of solid quality; proper citations and references are always provided	some issues with the quality and/or quantity of references; problems with proper citations and references.	minimal references; poor citations
effective integration of references into proposal	multiple references that are integrated and meaningfully discussed together throughout the proposal	multiple references with occasional integration of sources	multiple references but little integration	ineffective use of cited material; no integration or references not appropriate to the question
effective selection and description of proposed research methods	proposal reflects a clear description and feasibility of methods and methods are clearly linked to the research question	methods sufficiently described and linked to research questions	some aspects of methods are clear and effective; others lack detail/depth; linkage to questions not so obvious	methods poorly described and/or not appropriate for the proposed question
clear use of scientific data, tables, and/or figures to convey the current understanding of the research question [focusing on the literature review]	effective integration of supporting data, figures and/or tables into the proposal, from a mix of sources with appropriate context and interpretation	adequate use of supporting data, tables, and or figures throughout the proposal, although the context of the data (e.g., methods) needs more elaboration	some use of data in the proposal but lacking consistent and effective use of data, figures and/or tables	supporting data, including figures and/or tables, are not connected to the proposal text

Results

Effect of reviewer

Table 4 provides a summary of the faculty assessments of the student final proposals in Research Methods. Following our initial calibration described above, average scores across faculty members varied from 8.5 to 9.9 (out of a possible score of 15). There were more substantial differences in scores for the same student across different faculty members. Differences within individual criteria ranged from 0 to 2, and averaged 0.5 to 0.6 across the five criteria (out of a total possible score of 3). For the total scores, differences in individual scores ranged from 0 to 4.5 and averaged 1.9 (out of a total possible score of 15).

Based on these results, there is definitely some variation in terms of how the faculty apply the rubric, perhaps based on different expertise and emphasis of different elements within the final product. However, given that four faculty members evaluated narrative-type material with no clear right or wrong answers, there was remarkable consistency across the results. Some of the most pronounced differences in scoring were for students who were on the lower end of the scale, with scores below proficient or approaching proficient. The top scoring paper received a score of 13.5/15 from both reviewers.

Furthermore, there was no consistent difference between reviewers. Figure 1 shows a comparison of the faculty members total scores and uses each faculty's scores standard deviation as an error bar. The graph illustrates the slight difference in average scoring, but it also demonstrates that this variation falls within the error. Thus, the faculty assessments are reasonably consistent between faculty members.

Table 4. Summary of scores for PLO 3. Each faculty member ranked each criterion for each proposal on a scale of 0 - 3 points. The maximum score would have been 3 points in each category, for a total of 15 points.

criteria	April Randle	Tom MacDonald	Allison Luengen	John Callaway	**average**
research question	2.1	1.8	2.1	1.9	2.0
collection of resources	2.3	2.1	2.0	1.9	2.1
integration of resources	2.0	1.6	1.8	1.6	1.8
methods	1.8	1.4	1.9	1.9	1.8
data/figs/tables	1.5	1.6	2.1	1.6	1.7
Total	9.9	8.5	9.9	8.8	**9.3**

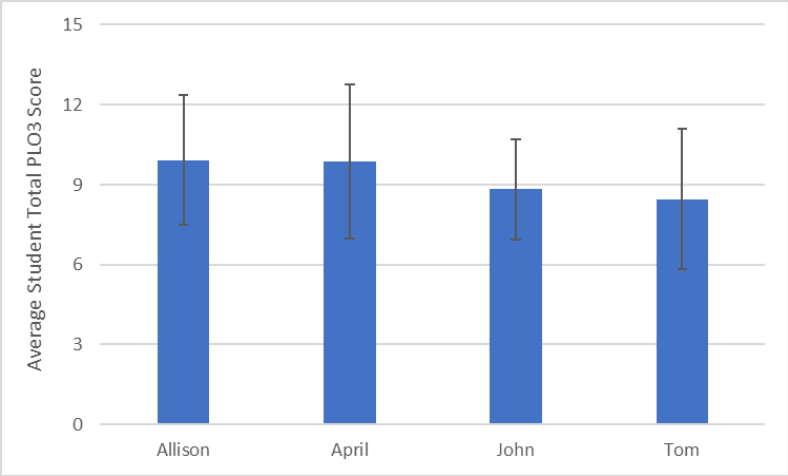

Figure 1. Average total PLO3 score from each faculty member with the standard deviation shown as an error bar. There were no statistically significant differences between the scores assigned by different faculty members.

Mastery of the learning outcome

The average score across all 48 evaluations of the 24 students was 9.3 (out of a possible score of 15). This is slightly below an average of 2.0 per criteria (proficient on the rubric above). Figure 2 shows that 19 of the 48 individual evaluations were equal to or above 10 (2.0 per criteria) and 29 evaluations were below 10. This result indicates that more evaluations were below proficient than those that were equal to or above proficient. An additional 21 evaluations ranked between 7.5 to 9.5, indicating mastery of some parts of the learning objective, with perhaps just one or two categories falling below proficient. A total of 41 of 48 evaluations had a final score of 7.5 or higher, indicating mastery of some of the learning outcomes. The remaining 7 evaluations scored 7 or less, which would mean that on average, they were less than proficient in every category and the learning outcomes were not mastered.

When the two evaluations from each faculty member were averaged to give a single score for each research proposal, 8 of the 24 research proposals scored equal or greater than 10, which was the criterion for proficient or higher. Thus, 8/24 or 33% of the students had mastered most parts or had completely mastered the learning outcome. The results indicate that there is substantial room for improvement regarding this PLO, as measured by the Research Methods course.

The curriculum map shows Mastery of PLO3 for the Research Methods course, but that expectation may be too ambitious and may not make sense given the sequencing of courses in the program. The Research Methods course is designed as a lead-in to develop skills and methods that will be used and applied extensively in the capstone Master's Project. Because Research Methods is a student's first course truly dedicated to these skills and methods, the

expectation of a student developing Mastery could be incorrect. If instead, the expectation was Development, then that level of expectation would be reflected in assessment of the student final proposals, resulting in scores that would be more in line with what can and should be achieved in Research Methods.

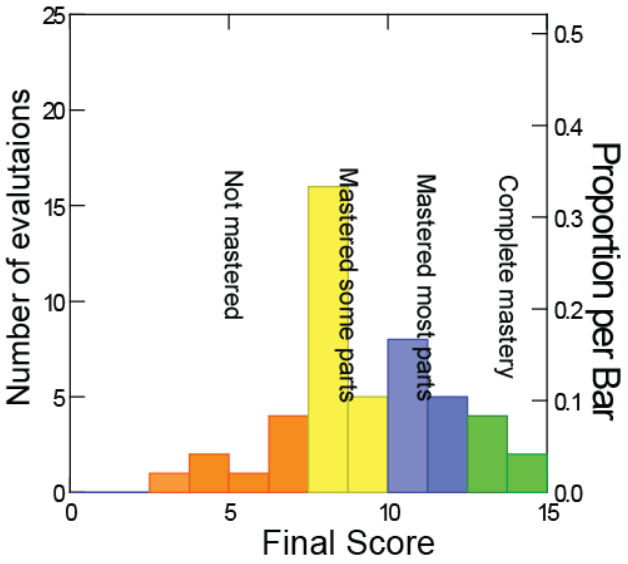

Figure 2. Histogram of final scores on 48 evaluations of the research methods proposals. The graph shows the number of evaluations (left-hand axes) or the proportion of evaluations (right-hand axes) achieving each score. The maximum score was 15. By convention, a data point falling on the line is included in the next-highest class.

When we broke the final scores into the five criteria (Table 4), average scores ranged from 1.7 to 2.1, with two criteria being equal to or above 2.0: those focusing on the research questions and the collection of resources (see rubric above for details on the criteria). The remaining three criteria averages were below 2.0: those focusing on the integration of resources, the methods, and the use of scientific data, figures and tables. These results suggest specific places where instruction could be improved.

Comparison with previous assessment

Our assessment team also evaluated PLO3 in the 2018 - 2019 Assessment Report, based on the three core courses (Environmental Chemistry, Ecology, and Quantitative Methods), rather than using the Research Methods course. In the evaluations of the Ecology course in 2018 - 2019, 73% of students had complete mastery or had mastered most parts of the learning outcomes. In Environmental Chemistry, 92% of the students had complete mastery or had mastered most of the outcome. Scores in Quantitative Methods were slightly lower, with 67% of the students demonstrating complete mastery or mastering most of the outcome. All three of these courses

demonstrated greater mastery of PLO3 than did the current assessment, where only 33% of the students demonstrated complete mastery or had mastered most of the learning outcome.

The markedly different assessment results indicate that the success in meeting the learning objectives varies dramatically depending on what work products are used. In the 2018 - 2019 assessment, the work products were final exams. Accordingly, the students were asked to choose a tool or technique, use the tool or technique, and analyze and interpret the results *all within the context of a single course*. In this assessment, students could choose any method so long as it matched their research question and was achievable. The challenge of picking the right tool was accordingly much greater. Unfortunately, the scenario in this assessment was much more real-world, and we would very much like the students to have the broader skill-set of picking an appropriate method from any available one.

Discussion of Results and Plans for Improvement

This report will be shared with the Environmental Science Department faculty, and the results will be discussed at an upcoming Department faculty meeting. The goals of the discussion are to use the assessment results to collectively evaluate ways to improve student performance on PLO3 in the future. Some possible improvement might come from modifying our assessment rubric using input from the entire department. Other improvements could relate to modifications to the course to better link assignments to PLO3.

Some of the reasons for the lower assessment scores may be due to the rubric and how that rubric was interpreted by the committee. It also may be that it is unreasonable for students to absorb and apply so much new material in the short space of an 8-week course in order to meet the descriptions of Exceptional in the rubric. In the program course sequencing and course content, most students come into Research Methods without ever being trained or performing a large-scale research literature review. Research Methods likely is also their first time truly learning about different methodologies for conducting literature-based research. In addition, while students have written many papers in other MSEM classes, the purpose of those classes and assignments is not to targeted at providing training in presenting data, tables, and figures, or other aspects of scientific writing skills. One consideration for the department is formalizing this training (by making Research Methods a required class) and moving it earlier in the curriculum.

It would also be worth considering how other electives, which are the majority of the MSEM curriculum, can help support this PLO and build on the material from Research Methods. Some of the criteria in the rubric (Table 3), such as integration of references and clear use of scientific data, appear to go beyond the objectives of PLO3, which simply states, “Choose and apply appropriate tools, techniques, and (or) technologies to analyze environmental issues.” The skills of synthesis and use of data need to be consistently taught and reinforced across the curriculum.

The department may also want to consider if these goals are adequately reflected in the program learning outcomes.

Other reasons for the lower assessment scores might lie in the course itself. The Department will want to examine how it can improve focus on PLO3, while still providing students everything else that is needed to prepare them for success in the capstone Master's Project. One possible modification could be to include clear instruction and expectation for different PLO3 expectations in earlier assignments. Some possible examples to consider are:

- how to properly present data/figures/tables,
- how to use published research papers as models for explaining their own methodologies,
- how to formulate rich research questions and clearly state them, and
- how to integrate papers in a literature review.

Another area that could improve PLO3 results is increasing coordination between sections and instructors. The reason to look at this issue is based only on our small sample size, but there was a statistical difference between the two sections based upon the Total scores from the faculty reviewers for PLO3 (1-way t-test, $p = 0.006$). This difference may only be due to differences in student make-up of the sections or other unusual conditions (it was a COVID lockdown semester), but it does provide some reason for looking into consistency between sections. Instructors have shared materials and approaches used over many semesters, but they also have developed new materials for their own sections. Continued coordination will be beneficial, including identifying successful approaches currently being used in each individual section.

Finally, future assessment may want to look at whether students ultimately achieve PLO3 upon completion of the Master's Project. Such an assessment would help to determine if it is appropriate to reconsider identifying Research Methods as developing this PLO and the Master's Project as mastering this PLO. Alternatively, it may be that the students do not ever achieve this PLO, in which case program goals and structure need to be rethought.

Past feedback

The response to our previous assessment resort on PLO4 using the Master's Project was positive. Since that assessment, the department has made efforts to improve consistency between sections of the Master's Project, as well as making efforts to improve upon the PLO4 results in the future. We will continue making these efforts, and we can evaluate their efficacy in a future year's assessment.