MEES Programmatic Learning Outcomes Assessment Report

October 2022

Academic years 2020-2021 and 2021-2022

2019-2022 MEES Learning Outcomes Assessment Committee Members:

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Executive Summary

The Marine Estuarine and Environmental Science (MEES) graduate program has a mission is to educate students to become the scientific leaders and problem-solvers of the future. To make good on this mission, we expect our students to achieve specific learning outcomes and we assess them on their progress towards mastery of those learning outcomes as a measure of the programmatic effectiveness. The process of programmatic assessment is developing and this report represents the first year we have a critical mass of data to be able to draw meaningful conclusions.

The MEES program is succeeding in meeting the goal of having 80% of graduating students meet our standards with a score of 4 or better on a scale of 1-5 (5 being outstanding performance). As we expected from anecdotal evidence through the years, our graduates are well trained scientists, according to the criteria we measure, including their disciplinary depth and breadth, professional skills, and ability to conduct and communicate scientific research. A majority of our graduates have jobs in their fields at the time of their defense.

None of the assessment points stood out as being particularly problematic. Instead, most of our students did fairly well in all areas. However, writing was one area where many students consistently scored lower compared to other skills. It is the most improved for most students, as measured by comparing the scores of more advanced students with those more recently matriculated, but was still the lowest scoring skill among graduating PhD students. We suggest a discussion in the MEES community about our writing expectations and pedagogy, for the above reasons. Can we improve the way we teach scientific writing skills and if so, how?

We also recommend improvements to our assessment process. A critical improvement is participation. Approximately 50% of students were evaluated in this report, an improvement over last year when we had data for ~30% of students. Ideally, we will bring this to 100% by continuing to remind faculty and students about the expectations of and value of the new assessment process. The committee recommends specific adjustments to the existing forms as well as the implementation of planned assessment points to be developed this academic year.

Introduction

The multi-institutional Marine Estuarine and Environmental Science (MEES) graduate program gathered a Learning Outcomes Assessment committee in the Autumn of 2019 with representatives from each of the MEES program campuses with a primary goal to develop a regular MEES program graduate outcomes assessment. The committee included 6 regular faculty members (representing each of the MEES campus'), the MEES program director, the UMCES VP for Education, and one student representative. The first year was focused on:

1. Refining our existing programmatic learning outcomes (Appendix A)
2. Mapping those learning outcomes onto our existing curriculum
3. Establishing a regular protocol for programmatic assessment of student learning (Appendix B)

In the second year we created the first assessment forms for faculty to assess student achievement. The forms are of two types, with a version for each MS and PhD students: 1) the annual assessment form, to be filled out by each committee member at the time of the annual committee meeting, and 2) Thesis/Dissertation defense form to be filled out at the end of the students' program and covering the oral defense (public and private sessions) and written thesis/dissertation. These forms are available on the MEES Faculty webpage under Learning Outcomes Assessments and were first implemented in the Spring 2021 semester. The first MEES Program Learning Outcomes Assessment Report was finished in the fall of 2021.

This report, in the fall of 2022 constitutes the second programmatic assessment of MEES students and is based on data provided by advisors and committee members after their annual committee meetings with students and after the student's defense. The data here represent February 2021 through September 2022, thus are based on 1.5 academic years' worth of annual committee meetings that occur every academic year. Future reports will be based on data from two academic years and on data from other sources as they are developed (see Appendix B, the protocol for programmatic assessment). The following are the learning outcomes assessed.

MEES Program Learning Outcomes

Master's Degree Learning Outcomes

1. **Program Learning Outcome 1**: Demonstrate working knowledge and comprehension of the fundamentals of environmental sciences within a disciplinary grounding.
2. **Program Learning Outcome 2**: Synthesize this disciplinary grounding and apply the resulting knowledge in an interdisciplinary context towards addressing important societal problems.
3. **Program Learning Outcome 3**: Learn and apply essential professional skills for scientific careers.
4. **Program Learning Outcome 4**: Under supervision, define, conduct, interpret and communicate original research.

Research Learning Outcome 4.1: Understand and synthesize pertinent information from the body of published scientific literature,

Research Learning Outcome 4.2: Conduct original research following scientific principles and protocols,

Research Learning Outcome 4.3: Analyze and interpret data from an original research project,

Research Learning Outcome 4.4: Write original research findings for a scientific audience, ideally at a standard suitable for publication in an appropriate, peer-reviewed scientific journal

Research Learning Outcome 4.5: Effectively communicate a technical summary of their research effort to a scientific audience in an oral presentation.

Ph.D. Degree Learning Outcomes

1. **Program Learning Outcome 1**: Demonstrate deep knowledge and thorough comprehension of the fundamentals of environmental sciences within a disciplinary grounding.
2. **Program Learning Outcome 2**: Synthesize this disciplinary grounding and apply the resulting knowledge in an interdisciplinary context towards the advancement of science and/or addressing important societal problems.
3. **Program Learning Outcome 3**: Learn and apply essential professional skills for scientific careers.
4. **Program Learning Outcome 4**: Independently define, conduct, interpret and communicate original research.

    Research Learning Outcome 1: Understand and synthesize pertinent information from the body of published scientific literature,

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    Research Learning Outcome 4: Write original research findings for a scientific audience, at a standard suitable for publication in an appropriate, peer-reviewed scientific journal

    Research Learning Outcome 5: Effectively communicate a technical summary of their research effort to a scientific audience in an oral presentation.

Annual Evaluations PhD

Participation by faculty in the assessment process improved substantially compared to the first assessment last year, but there is still room for improvement especially from committee members. In this round, 135 evaluations were submitted for 46 PhD students by 78 faculty and committee members. The MEES program had 91 registered PhD students in the 2020-2021 school year, providing a 50% participation rate, up from only 27% in the first year of implementation. On average, each student had 2-3 evaluations which were averaged into a single score per student before compiling into program averages. Of the 135 responses, 32%

came from advisors, and 68% came from committee members (Figure 1), similar to last year. Given that PhD students must have 4 or more committee members in addition to their primary advisor, there is currently a lack of responses from committee members. Responses came from all 4 of our Foundation Areas (Figure 2)

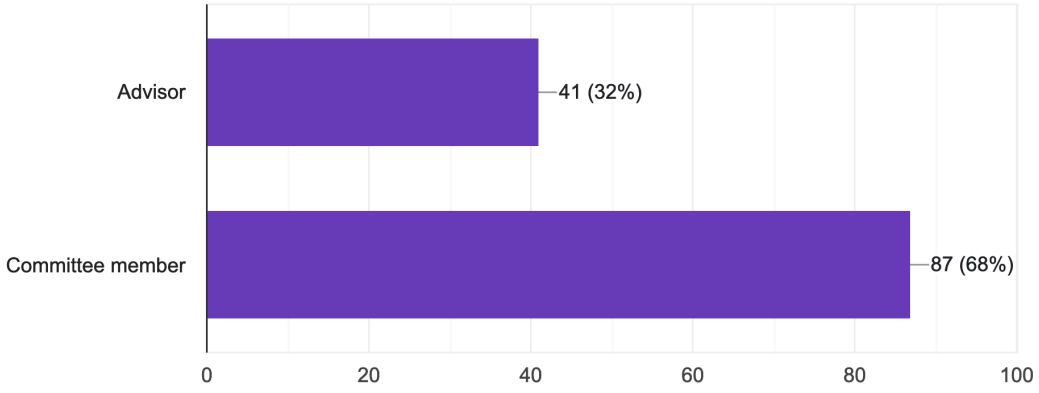


Figure 1. Number of Advisors vs Committee members assessing. Note the total is less than the actual 135 responses for Ph.D. students because some faculty filled out Masters level forms for PhD students and the error can only be corrected downstream from this graph in the data analysis.

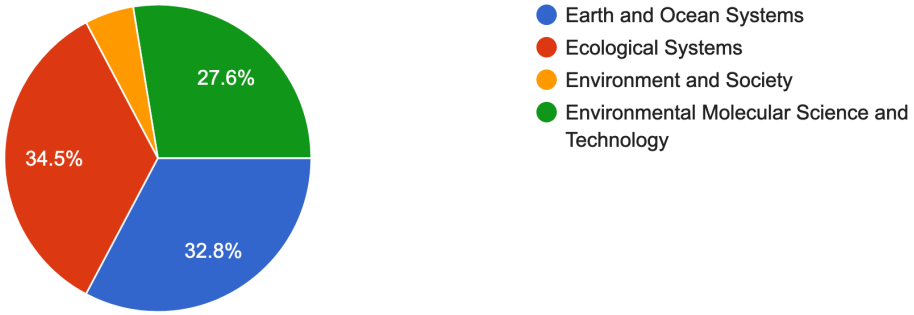


Figure 2: Foundation Areas represented in the responses. Note, some students are still in the old AOS system and thus are not represented.

The average score for all students in each of the learning outcomes ranged between 3.86 and 3.36 with standard deviations of 0.81 to 0.97, and there is a clear pattern of improvement over time. Students clearly strengthen and mature with more time in the program, demonstrated by lower average scores for students who have been in the program less than two years and average scores between 4.4-4.7 for students who were graduating. These scores meet or exceed our stated goal of 80% of graduating students with scores of 4/5 in each Learning Outcome area. This is based on a cohort of 9 graduates – each with their individual strengths and weaknesses. Looking at all 46 PhD students on average, mentors rated their foundational knowledge highest (Learning Outcome 1) and their scientific writing skills lowest (Learning

Outcome 4.4). Ph.D. students' scientific writing skills were ranked the lowest of all skills. ***This indicates that improving student writing skills is a potential growth area for the program.***

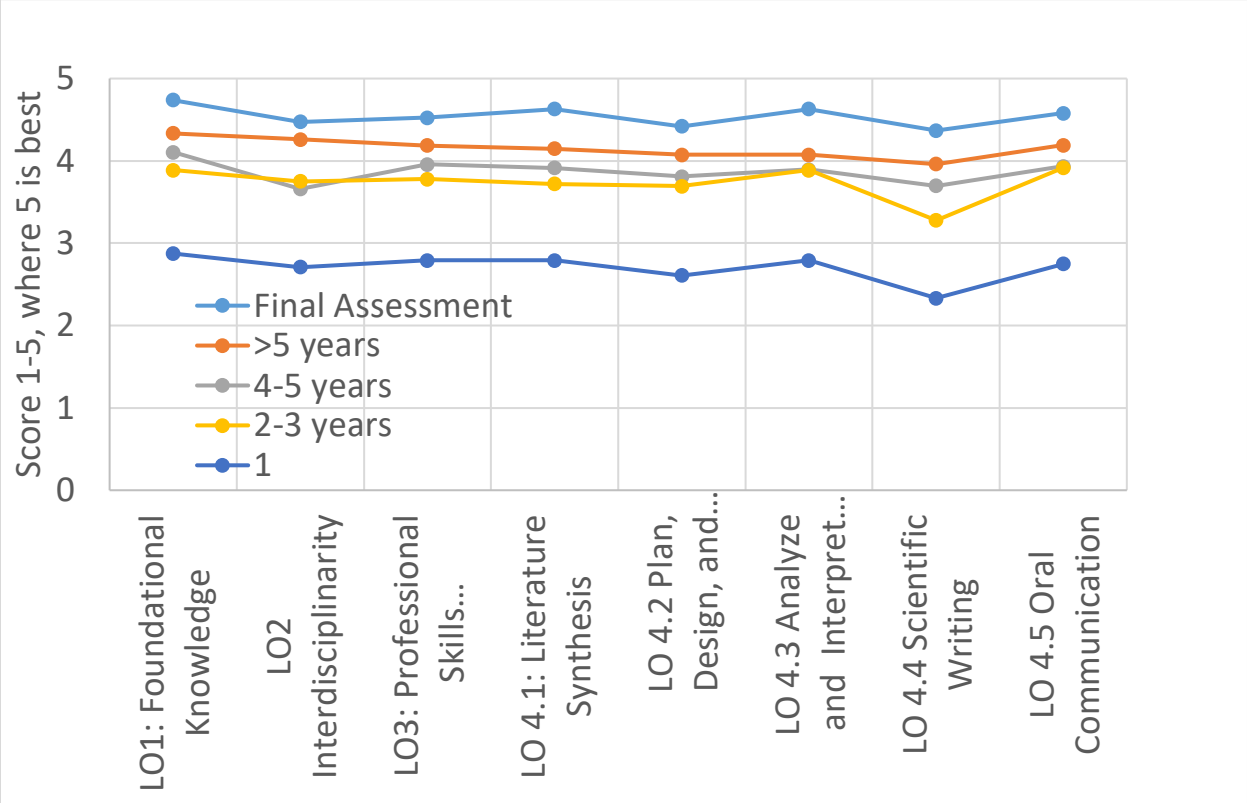


Figure 3: Average assessment scores for 45 PhD students, based on 135 faculty assessments of their performance in each of the Learning Outcome areas.

The particular skills our PhD Students are mastering vary by student and by the faculty member who is assessing (Figure 4). The assessment question asked what skills students are working on, but not necessarily that they have mastered yet. Unsurprisingly, the most common skills students are learning are Laboratory and Field Techniques, Data Analysis – theory and software, and scientific communication- oral and written. ***Future skills assessments would be more informative if student performance was rated in these skills.*** Although scientific writing is a skill most students are working on, our evaluations of their current skills indicated scientific writing is lowest. ***The learning outcomes assessment committee should consider discussing with faculty who specialize in Molecular techniques and bioinformatics regarding the need for a new category, or explicit inclusion of those topics in laboratory techniques and/or data analysis to improve the assessment form.***

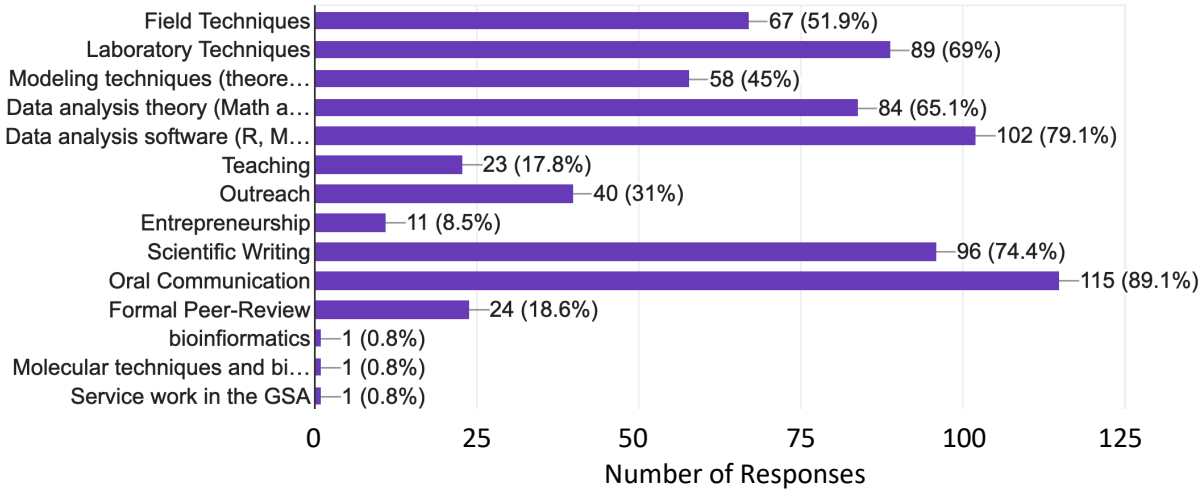
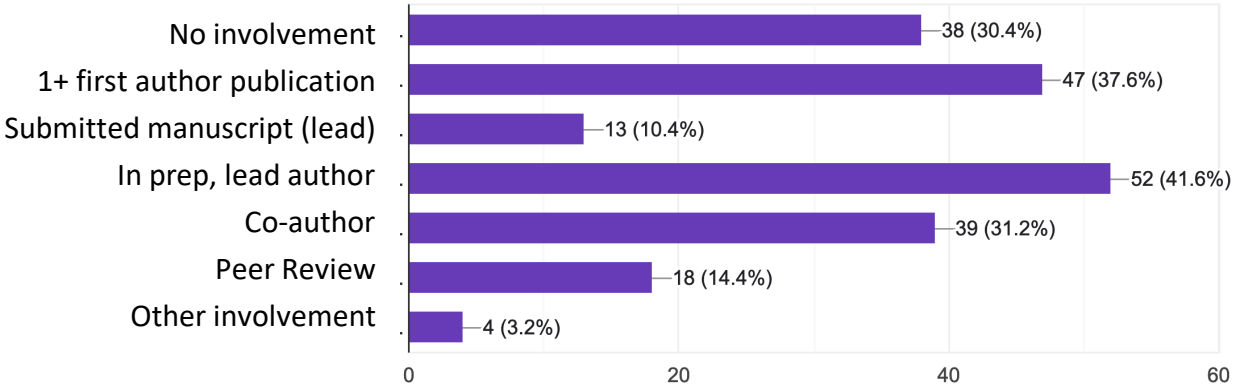


Figure 4: Professional Skills PhD students are learning or have mastered.

Another metric of our students is their involvement in publication in the peer-reviewed literature (Figure 5). The data are not easily broken down by student because they include multiple responses from multiple mentors of any given student. A large proportion of respondents indicated our PhD students have some involvement in professional publications as first authors. Surprisingly, nearly 1/3 of responses indicated the student had no involvement. Since about 1/3 of responses were for students in their first 2 years of a PhD, this result likely represents students early in their educational path and who have not yet had the opportunity. ***It is recommended that the committee change the format of the publication question in the online forms so that only one response is given per student per year.***



Annual Evaluations MS

Participation was slightly lower for MS students than for PhD students, but still improved over last year. 60 evaluations were submitted for 25 different MS students. The MEES program had 58 registered MS students in the 2020-2021 school year, providing a 43% participation rate, up from a 29% participation rate last year. On average, each student had 2-3 evaluations which

were averaged into a single score per student before compiling into program averages. Of the responses, 46% came from advisors, and 54% came from committee members, the same as last year (Figure 6), again indicating a lack of participation on the part of committee members. Responses came from primarily Ecological Systems and Earth and Ocean Systems, two of our four Foundation Areas (Figure 7).

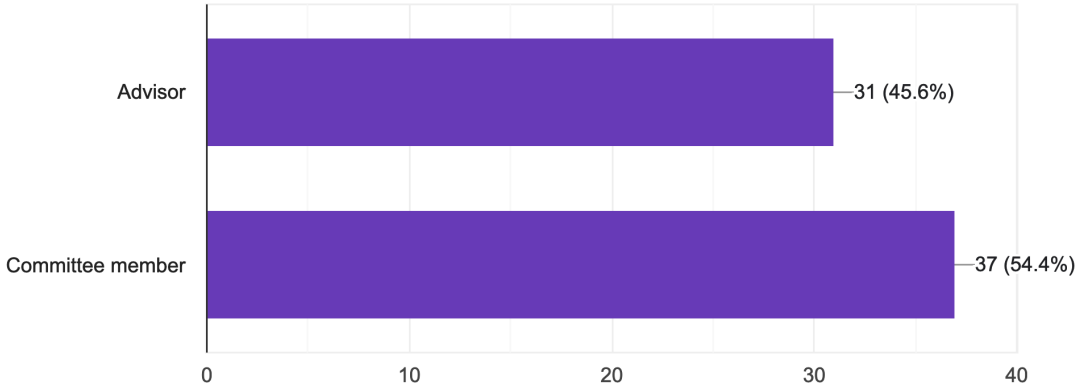


Figure 6: Proportion of Annual Evaluations (MS) submitted by Advisors and Committee members.

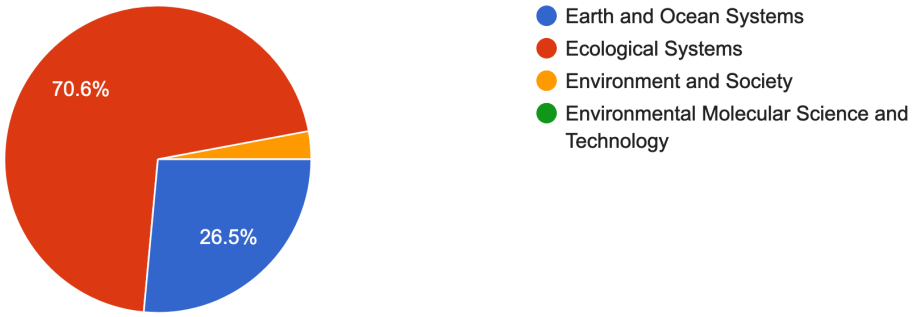


Figure 7: Foundational Areas represented in the data for MS students

The average score for all MS students in each of the learning outcomes ranged between 2.95 and 3.63 with standard deviations of 0.97 to 1.18 (Figure 8). Students clearly showed significant learning with more time in the program, demonstrated by average scores in the 2-3 range for students who have been in the program one year and average scores between 4.1-4.4 for students who are graduating. The scores exceed our stated goal of 80% of graduating students score at least 4/5 in each Learning Outcome area (Figure 9). Looking at all of the MS students on average, mentors rated their foundational knowledge (Learning Outcome 1) highest, whereas scientific writing skills were rated the lowest (Learning Outcome 4.4). A similar pattern is not seen in our 7 graduates in this cohort, who as a whole rated lowest in Professional Skills Development (Learning Outcome 3) and Literature synthesis (Learning outcome 4.1). The pattern of highest and lowest rankings among graduates this year is different from last year, indicating some year-to year variability depending on sample size and specific students in the cohort. More data is needed to identify robust patterns that could be used to improve the

program. The one thing that is consistent is our incoming students ranking low in writing skills. ***Thus it is likely our MS students would benefit from increased focus on writing skills in the program.***

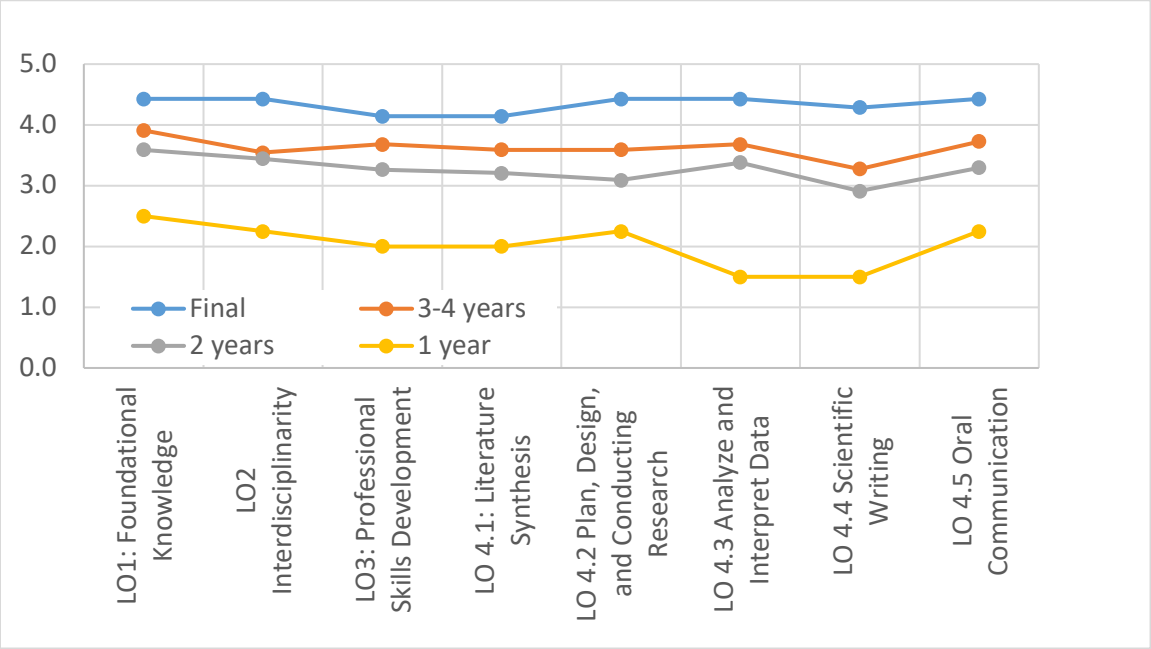


Figure 8: Average assessment scores for 25 MS students, based on 60 faculty assessments of their performance in each of the Learning Outcome areas.

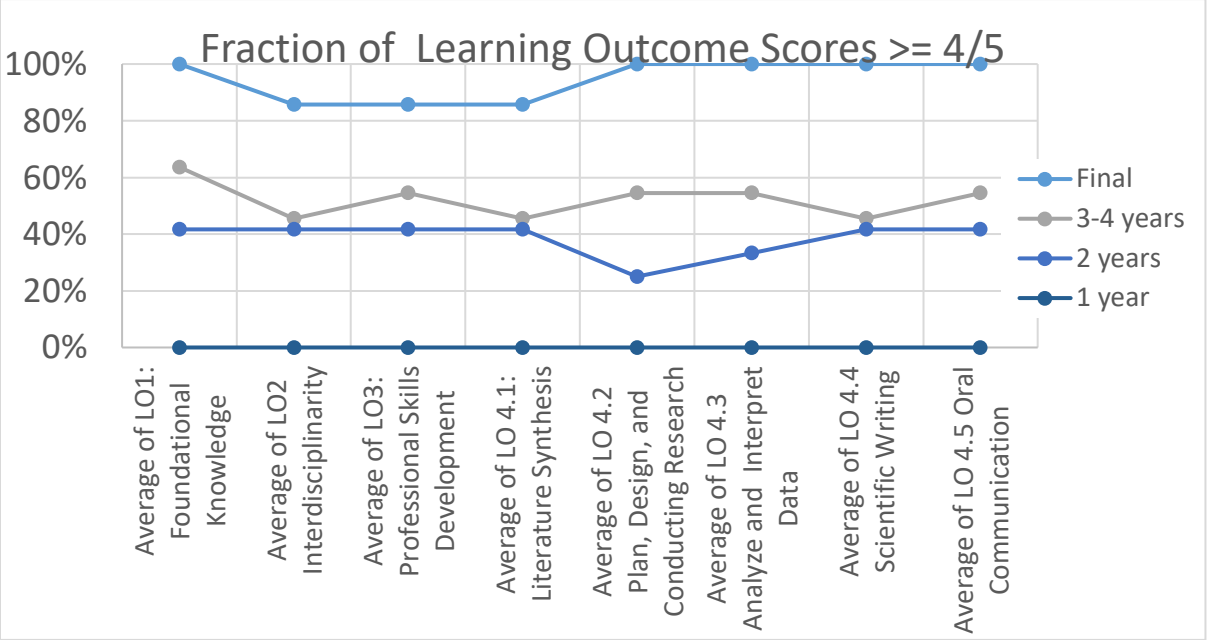


Figure 9: Fraction of Learning Outcome scores greater tthan or equal to 4 out of 5 for 25 MS students, based on 60 faculty assessments of their performance in each of the Learning Outcome areas.

The particular skills our MS students are learning vary by student and by the faculty member who is assessing (Figure 10). The most common answers are Data Analysis – theory and software, and oral scientific communication. ***Future iterations of this question would be more informative if student performance was rated in these skills.***

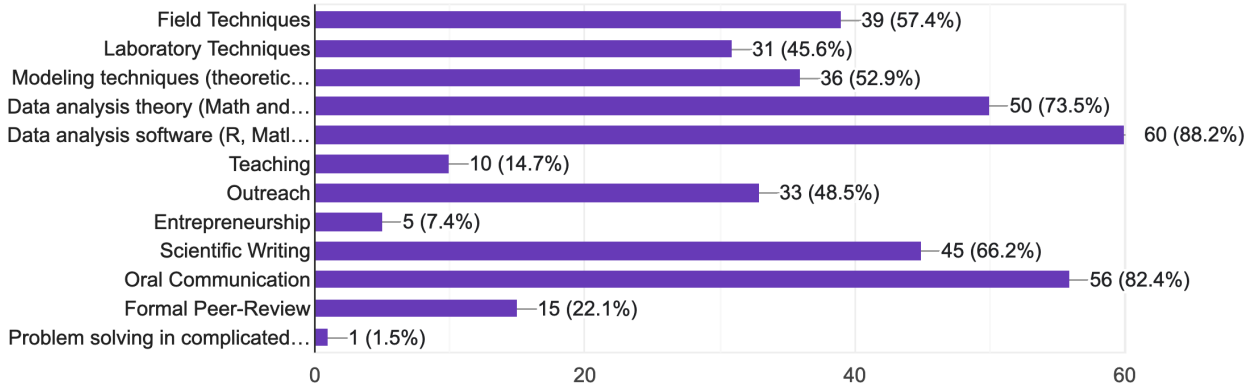


Figure 10: Professional Skills MS students are learning or have mastered. The bottom skill is a write-in, "Problem solving in complicated field environments."

Another metric of our students is their involvement in publication in the peer-reviewed literature (Figure 11). The graphic below is misleading because each student may have multiple responses. A slim majority of MS students have not been involved in the peer-reviewed publication process, but this mostly reflects the population of students early in their program of study. Of our 7 graduating MS students, only 1 already had a publication but most either had been involved as a co-author or were preparing a manuscript as a lead author. Only 2/7 or 29% of the graduating MS students had not had opportunity to be involved in professional publications. This is up from 75% last year and demonstrates that there is substantial year to year variations depending on who graduates and what the emphasis has been in their studies.

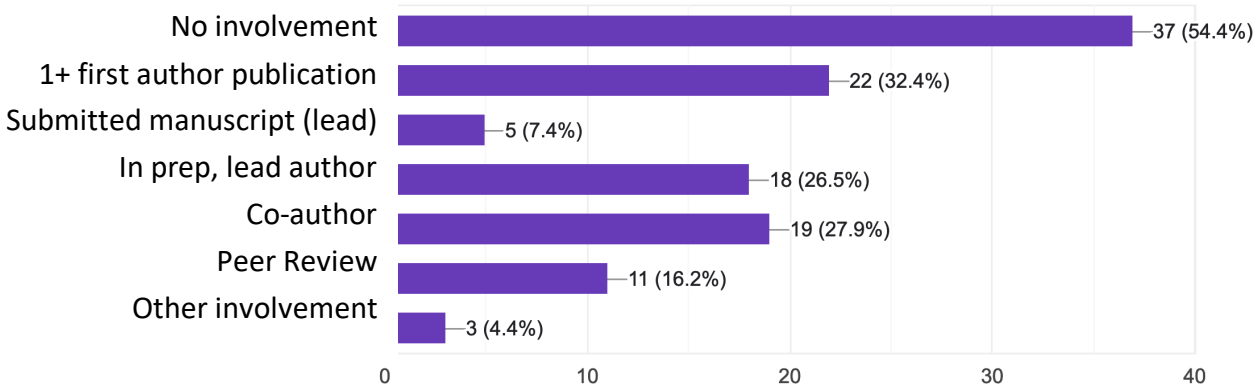


Figure 11. Reported involvement of our MS students in the peer review publication process.

End of Program Evaluations of MS and PhD

Assessments of students' oral communication skills and written theses or dissertations were made at the time of their defense. For MS students, the data are based on 16 evaluations of 11 students. Committee member responses were lacking. For PhD students, the data are based on 40 evaluations of 15 students. We present the aggregated data in two tables addressing the written thesis, a demonstration of Learning Outcome 4.4, in Table 1, and the oral defense, a demonstration of Learning Outcome 4.5, in Table 2.

Table 1. Written thesis or dissertation: Aggregate scores of graduating students from April 2021 to August 2022 on specific aspects of their written thesis.

Score 1-5 with 5 high. Goal: >80% students score at least 4/5	**MS Average**	**MS scores ≥4**	**PhD Average**	**PhD scores ≥4**
Provides a cogent foundation of the research area on which the student's work is based.	4.3	91%	4.45	80%
Effectively identifies a gap in knowledge and articulates an original research project designed to contribute novel information to the body of knowledge.	4.3	91%	4.525	87%
Clearly and accurately reports the student's research methodology.	4.3	82%	4.5	87%
Clearly and accurately reports the student's research results.	4.1	82%	4.4	80%
Thoroughly discusses the relation of the student's research to other relevant current studies and identifies future avenues of investigation that may be needed or warranted.	3.9	73%	4.25	80%
Includes sufficient citations to the key studies in a manner that conveys command of the professional literature in the student's specialty.	4.1	91%	4.6	87%

Table 2. Oral defense: Aggregate scores of graduating students from April 2021 to August 2022 on specific aspects of their oral defense.

Score 1-5 with 5 high. Goal: >80% students score at least 4/5	**MS Average**	**MS scores ≥4**	**PhD Average**	**PhD scores ≥4**
Addresses questions thoughtfully, thoroughly, and accurately without the need for excessive assistance from the committee.	4.3125	91%	4.4	80%
Articulates clearly the relation of the work to the core hypotheses/research questions of the study and/or important observations that will advance the field.	4.25	91%	4.5	80%
Describes and justifies methods and analytical choices	4.125	82%	4.45	87%
Interpret the meaning and significance of the data, potential alternative explanations, and implications of the results.	4.0625	82%	4.325	87%
Addresses clearly what gaps in the literature and scientific questions have been answered by the work, and what questions remain.	4.125	82%	4.5	87%
Articulates what work should come next and how the study laid the foundation for that work.	4.25	82%	4.45	87%

An additional measure of programmatic success is the number of students who have a job or position lined up in their field at the time of graduation. Faculty respondents indicated that 69% of graduating MEES students had a position in their field at the time of graduation, with PhD students having a slightly lower rate of employment, 67%, compared to M.S. students, 73%. At least one of the PhD students is not seeking employment right away because of the decision to prioritize starting a family before starting a career, which accounts for the difference between M.S. and Ph.D.'s. The coincidence of biologically prime reproductive years with graduate education and the increased participation of women in academia means this factor will likely become a repetitive pattern.

Time to graduation is another metric of programmatic success and our students are graduating in reasonable time. For MS students, the average time to graduation is 3.1 years and for Ph.D. students it is 4.9 years. This is slightly longer than the traditional 2 and 4 years for M.S. and Ph.D., but is on par with similar programs today.

Looking Forward in the MEES Program

The data show that the MEES program is effectively improving student's skills in the areas we intend. Faculty assessments of the students' performance is much higher at the time of graduation than in the first year or two of the student's tenure. We are meeting our stated goal of 80% of students rating either 4 or 5 out of 5 in each of our Learning Outcomes skills.

Pedagogical Improvements

Improvements can always be made. Scientific writing is a skill that few, if any, of our students arrive with and it remains the weakest point for our graduating Ph.D. students. This is a potential growth area for the program, where improved focus on teaching these skills could lessen the burden of teaching writing skills individually to students through iterations of editing theses and dissertations. Discussion among the committee led to a variety of thoughts and ideas for potential directions, listed below. Final recommendations by the committee will be formalized after a discussion among students and faculty at the 2022 MEES Colloquium.

- Targeted instruction in scientific writing or writing workshops may help students improve. We have a scientific writing seminar that some students find to be very helpful and others find not as helpful. How can we predict who will benefit?
- Courses that include a writing component to them could focus on writing skills more by discussing writing skills in class, peer review of writing among students, and structuring assignments so that there is opportunity for revision and improvement.
- A consistent rubric used for the evaluation of scientific writing could help students better understand scientific writing expectations and help faculty express better what is lacking in any given piece of writing. See Table 3 on the next page. for an example.
- Analysis of good writing, including breaking down organizational structure and sentence structures, can help students learn the components of good writing. How can we incorporate this into the MEES program?

Improvements in Assessment

Several improvements to the program assessment itself are needed. First the assessment is based solely on forms filled out by faculty that rate student performance somewhat subjectively. Expansion of the assessment to include other measures is recommended. Specifically, student work in the required Applied Environmental Science course can provide information towards Learning Outcome 2 - *Synthesize disciplinary knowledge and apply it in an interdisciplinary context towards addressing important societal problems,* and should be implemented in the next report. Development of appropriate assessments addressing Learning Outcome 1 – *foundational knowledge,* using purpose-made assignments in the required Foundation courses should be a goal for future years.

Specific improvements to the existing assessment forms clearly fall from this analysis. The specific skills assessment question needs to include a rating for each skill to make the data more usable. A few of the faculty put write-in answers for this question that indicate the students are learning bioinformatics, and the committee should follow up with those faculty to see if bioinformatics is needed separately from data analysis tools or data analysis theory. The format of the peer-reviewed publication question in the online forms needs to change so that only one response is given per student per year. One way to do this could be to have only advisors answer the question. The advisors usually know on which publications the students are working.

Table 3 Example of a universal science writing rubric from Pisano et al., 2021[1]

Parameter	Absent	Emerging	Proficient	Mastery
Scientific content (C)	Scientific content presented is inaccurate	Scientific content presented is accurate, but there are elements of the scientific story missing (either scientific findings or process are described insufficiently)	Scientific content presented is accurate, and both findings and process are described, but the story may be disjointed	Scientific content (both findings and process) is accurate, and scientific ideas are integrated to tell a story
Interpretation of scientific content (I)	There is no interpretation of the scientific findings OR there was an incorrect interpretation (e.g., false confidence, correlations presented as causations)	An attempt was made to interpret the scientific findings and place them in the context of the field; scientific uncertainty or limitations are mentioned	There is a deeper discussion that interprets the implications and/or limitations of the studies in the context of the field	The interpretation is holistic, discussing implications and uncertainties of the findings in the context of the field, and is explained well for the genre of the paper
Targeting the audience (T)	The writing was not targeted well to the intended audience (e.g., the main thesis of the writing was not appropriate for the intended audience)	An attempt was made to gear the writing toward the intended audience, but there were still issues with the level of detail (too detailed content or not enough description) for the audience	An attempt was made to gear the writing toward the intended audience, but there were still small issues with language (e.g., too much jargon for a lay audience, too colloquial for a scientific audience)	Content, organization, and language were all geared appropriately towards the intended audience

[1] Pisano A, Crawford A, Huffman H, Graham B, Kelp N. 2021. Development and validation of a universal science writing rubric that is applicable to diverse genres of science writing. J Microbiol Biol Educ 22:e00189-21. https://doi.org/10.1128/jmbe.00189-21.

Final Thoughts

This report represents our first full assessment based on 2 years of data. The next steps for implementing learning outcomes assessment involve increasing the assessment points, increasing participation, and refining the data acquisition process. The original assessment plan (Appendix B) included student performance related to the content of three required courses, 1) a Foundation course, 2) Applied Environmental Science and 3) an Issue Study Group course. Assessment plans/protocols need to be developed and implemented for these courses, with the first priority to be the Applied Environmental Science course and then the Foundation courses. Plans to increase participation include increased advertising through emails to faculty and students and involving the major advisor in collecting responses from their students committee members. A presentation of this report at the MEES colloquium, a community discussion session dedicated to the results, and individual committee member outreach on their campus' are all intended to increase awareness of the need for advisors and committee members to participate.

APPENDIX A: MEES Learning Outcomes

Master's Degree

5. **Program Learning Outcome 1**: Demonstrate working knowledge and comprehension of the fundamentals of environmental sciences within a disciplinary grounding.
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    Research Learning Outcome 4.1: Understand and synthesize pertinent information from the body of published scientific literature,

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    Research Learning Outcome 4.5: Effectively communicate a technical summary of their research effort to a scientific audience in an oral presentation.

Ph.D. Degree

5. **Program Learning Outcome 1**: Demonstrate deep knowledge and thorough comprehension of the fundamentals of environmental sciences within a disciplinary grounding.
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    Research Learning Outcome 5: Effectively communicate a technical summary of their research effort to a scientific audience in an oral presentation.

APPENDIX B

MEES Learning Outcome Assessment Protocol

Created May 19, 2020, last updated October 2020
MEES Learning Outcomes Committee 2019-2021

Mission: The mission of the University System of Maryland graduate program in Marine Estuarine and Environmental Science is to provide students with a broad knowledge base, to develop critical thinking and cross-disciplinary working skills, to train scientists to design and execute novel and significant research. We train students for employment as academic teachers and researchers and as practitioners in industry, government, and non-profit organizations.

Responsibility for Assessing Outcomes and Reviewing Results: Faculty provide assessments for each student at each curriculum milestone indicated, each year. Where multiple faculty inputs are given for a single student, such as in assessments provided by committee members, the scores of a single student will be averaged into one score for that student, for that assessment, though the original individual scores will be maintained for administrative analysis purposes. The MEES administrative office will maintain the database, but the data compilation will be automated to the extent possible. The MEES office will provide the raw data to the standing MEES Learning Outcomes Assessment Committee for analysis. An attempt will be made to compose the committee with faculty representing each campus involved in the MEES program. The committee will conduct annually a formal of the learning outcomes each year. The assessment report may include recommendations for improving the program to enhance student learning and/or recommendations for improving the assessment itself. The report will be submitted to all MEES faculty, including the MEES director for action on the recommendations. The chair of the committee will present the findings of the MEES Learning Outcomes Assessment Committee annually at the MEES colloquium.

In the first 1 year of implementation, the program assessment will be in a trial phase and each LO will be assessed, with the single year of data available. Emphasis will not be on the student outcomes (because of the limited cohort size) as much as on the process of the assessment. Questionnaires of the faculty conducting the assessment will be included so that recommendations can be made for improving the rubrics, performance targets, and processes for the following year.

FORMS NEEDED in the following plans, see next page [To be made, 4 and 5 are priority]

1. Foundation course subject tests (same for MS and PhD)
2. Applied Environmental Science rubric (same for MS and PhD)
3. Issue study group rubric (same for MS and PhD)
4. Annual Committee Meeting Rubric on all LOs (contains a specific line about a proposal)
5. Oral and Written Defense rubric – for LOs 1, 2, 3, 4 for MS students, and for PhD
6. PhD Comprehensive exam rubric -needs coordination with clear Comps requirements., Focus on LO1 and LO2.

MS Program Learning Outcomes	Methods Used for Assessment of Student Achievement	Program Performance Target for Each Assessment Method
LO1. Demonstrate working knowledge and comprehension of the fundamentals of environmental sciences within a disciplinary grounding.	1. Subject test at the end of the foundation course (same across all instructors for a single foundation) 2. Committee filling out a rubric at the defense, based on the written thesis and oral defense 3. Annual Committee meeting rubric	1. 80% pass (80%) rate 2. Average score of 4/5 or better among all students. 3.Average score of 4/5 or better among all students.
LO2. Synthesize this disciplinary grounding and apply the resulting knowledge in an interdisciplinary context towards addressing important societal problems.	1. The instructor assesses students at the end of Applied Environmental Science . 2. Assessment reported by the instructor of the required issue study group course via a standardized rubric. 3. Annual Committee meeting rubric	1. Average score of 4/5 or better among all students. 2. Average score of 4/5 or better among all students. 3. Average score of 4/5 or better among all students.
LO3. Learn and apply essential professional skills for scientific careers.	1.Each committee member assesses student's demonstrated professional skills at the time of approval of the thesis. 2. Annual Committee meeting rubric	1. Average score of 4/5 or better among all students. 2. Average score of 4/5 or better among all students.
LO4. Under supervision, define, conduct, interpret and communicate original research.	1. The student's committee members assess performance in the student's written and oral thesis at the time of the oral defense. 2. Annual Committee meeting rubric	1. Average score of 4/5 or better among all students. 2. Average score of 4/5 or better among all students.

PhD Program Learning Outcomes	Methods Used for Assessment of Student Achievement	Program Performance Target for Each Assessment Method
LO1. Demonstrate deep knowledge and thorough comprehension of the fundamentals of environmental sciences within a disciplinary grounding	1. Subject test at the end of the foundation course (same across all instructors for a single foundation) 2. Assessed by the committee based on the performance of the student during comprehensive exams, scored by a rubric. 3. Committee filling out a rubric at the defense, based on the written thesis and oral defense 4. Annual Committee meeting rubric	1. 80% pass (80%) rate 2. Average score of 4/5 or better among all students 3. Average score of 4/5 or better among all students. 4. Average score of 4/5 or better among all students.
LO2.Synthesize this disciplinary grounding and apply the resulting knowledge in an interdisciplinary context towards the advancement of science and/or addressing important societal problems	1. Assess students at the end of Applied Environmental Science 2. Assessment reported by the instructor of the required issue study group course via a standardized rubric. 3. Annual Committee meeting rubric	1. Average score of 4/5 or better among all students. 2. Average score of 4/5 or better among all students. 3. Average score of 4/5 or better among all students.
LO3. Learn and apply essential professional skills for scientific careers.	1. Each committee member assesses student's demonstrated professional skills at the time of approval of the thesis. 2. Annual Committee meeting rubric	1. Average score of 4/5 or better among all students. 2. Average score of 4/5 or better among all students.
LO4. Independently, define, conduct, interpret and communicate original research.	1. The student's committee members assess performance in the student's written and oral thesis at the time of the oral defense. 2. Annual Committee meeting rubric	1. Average score of 4/5 or better among all students. 2. Average score of 4/5 or better among all students.

Other information that will be used in the programmatic assessment and will be on an assessment rubric

a. The number of students with at least one peer review paper accepted at the time of graduation

b. The number of students with jobs in their field lined up at the point of graduation (later?, how to keep track?)

Points of assessment in the current document:

Foundation Course
Applied Env Science
Issue Study Group
Annual Committee (contains a specific line about a proposal)
Comprehensive exam (PhD)
Written Defense
Oral Defense