GEORGE MASON UNIVERSITY
MASON CORE ASSESSMENT REPORT:
NATURAL SCIENCES
AY 2014

The Mason Core (formerly General Education) program at George Mason University organizes courses of study into three main areas. *Foundation* courses build knowledge and skills to promote success in the major and in future pursuits; *core* courses introduce students to a breadth of subject matter and intellectual traditions; and *synthesis* courses encourage the integration of past learning and experiences, develop critical thinking skills, and prepare students for lifelong learning. Student learning outcomes for the Mason Core areas are created and assessed by faculty, primarily through the University Mason Core Committee. Results of assessment activities are reported to the faculty, the Mason community, and the State Council of Higher Education for Virginia (SCHEV) by the Office of Institutional Assessment.

Courses approved for inclusion in the Natural Sciences (NS) category meet the *core*-level requirement for Mason undergraduates. All Mason undergraduates must pass two approved science courses equaling seven credits, with at least one course that includes a laboratory experience. Specific courses and sequences may be required by certain majors or degree programs.

Learning Outcomes

Mason Core Natural Science courses engage students in scientific exploration; foster their curiosity; enhance their enthusiasm for science; and enable them to apply scientific knowledge and reasoning to personal, professional and public decision making.

To achieve these goals, students will:

1. Understand how scientific inquiry is based on investigation of evidence from the natural world, and that scientific knowledge and understanding:
    a. Evolves based on new evidence
    b. Differs from personal and cultural beliefs
2. Recognize the scope and limits of science
3. Recognize and articulate the relationship between the natural sciences and society and the application of science to societal challenges (e.g., health, conservation, sustainability, energy, natural disasters, etc.)
4. Evaluate scientific information (e.g., distinguish primary and secondary sources, assess credibility and validity of information).
5. Participate in scientific inquiry and communicate the elements of the process, including:*
    a. Making careful and systematic observations
    b. Developing and testing a hypothesis
    c. Analyzing evidence
    d. Interpreting results

*Lab courses must meet all five of the above learning outcomes. Non-lab courses must meet learning outcomes 1-4.

Courses Approved for the Natural Sciences Requirement Fall 2013 Catalog

ASTR 103, 111, 112, 302; BIOL 103, 104, 213; CDS 101; CHEM 101, 103, 211, 212, 251; CLIM 101; EVPP 110, 111, 201; GEOL 101, 102; GGS 102, 121; NUTR 295; PHYS 103, 160, 161, 243, , 244, 245, 246, 260, 261, 262, 263; UNIV 301.

Previous Assessment

Previous Natural Sciences competencies were assessed in AY 2007-08 using a faculty-developed pre-post competency assessment exam. The multiple-choice pre-test was administered to 2,163 students taking the first of the two-course sequence in seven 100-level course sequences (ASTR 112/114, BIOL 103/104, CHEM 101/103, CHEM 102/104, EVPP 110/111, GEOL 101/102, PHYS 103/104) in fall 2007. The post-test was administered to 971 students in the second of the two-course sequence in spring 2008. Analysis of results showed that student scores did not improve significantly from the pre- to post-assessment. Following these results, a committee comprising faculty and administrators from the College of Science engaged in faculty development efforts, a restructuring of the curriculum, and the development of a new set of general education learning outcomes.

In 2008-09, Mason adopted a course portfolio assessment process for all of the General Education categories. Courses in the respective categories are now assessed on a six-year cycle, with adjustments in this schedule made as needed.

Data Collection and Assessment Process

The assessment of the Mason Core Natural Sciences category was conducted in fall 2013 and spring 2014. Sixteen courses (twenty-one sections) were randomly selected for assessment. Information sessions were conducted for course instructors in spring 2012, followed by individual consultations upon request. Each instructor was asked to create a course portfolio that consisted of a summary sheet, course syllabus, course map of activities and assessments, selected course assignments, samples of student work, and a brief narrative. The portfolios were due two weeks after the end of the semester, and were submitted via Blackboard.

Seventeen of the twenty-one instructors submitted portfolios as requested. See Appendix for more information.

Portfolio reviews were conducted in spring 2014. Reviewers were members of the University Mason Core Committee and subject-matter faculty who participated in a training session that covered the review process and criteria. Reviewers entered ratings and text into an online review form. Each portfolio was reviewed by two independent reviewers.

- Total number of Mason Core NS courses offered in review period: **28** courses (**61** sections) across **3** colleges/academic units
- Total number of students enrolled (lecture sections only): **4,962**
- Total number of courses/sections selected for assessment: **16 courses/21 sections**
- Total portfolios collected: **17** portfolios representing **14** courses. The course instructors who created the portfolios taught a total number of **1,896** students (**38.2%** of the total NS course enrollment)
- Total reviewers: **13**
- Total student work samples reviewed: **89 work samples from lecture courses, 168 samples from laboratories, and 2 sets of exam scores**

Results

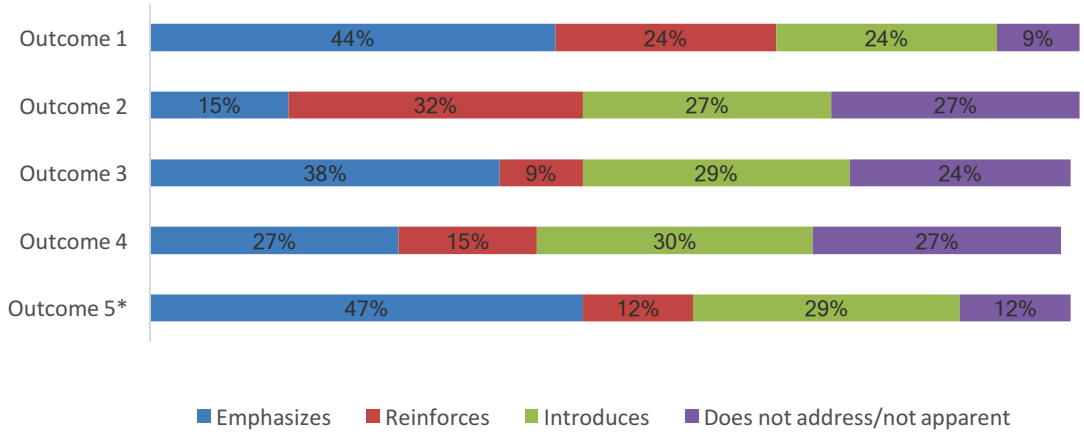
The course portfolio review focused on how well each course addressed the Mason Core student learning outcomes through instruction, assignments/activities, and samples of student work. Portfolios were assessed on how well the instructors articulated the learning outcomes for students, the congruence of the NS learning outcomes with the course content, the appropriateness of the course material for the Mason Core curriculum, and the appropriateness of the assignments or forms of assessment in relation to the NS learning outcomes. This section presents the aggregated results of the reviews in terms of the learning outcomes, the student work samples, and overall ratings.

Learning Outcomes

Using course materials, reviewers were asked to identify the level that each learning outcome was addressed in each course. "Introduces" indicates that students are introduced to the concept; "reinforces" indicates that students have had some experience with the concept and had opportunities to practice; "emphasizes" indicates that students have had sufficient practice and can now demonstrate mastery. The identification of levels in course content is important because it provides information about student preparation to instructors who use these courses as prerequisites. It also helps instructors gauge the appropriate level for constructing their course activities.

NS courses with labs must fulfill all five learning outcomes whereas lecture-only courses must meet learning outcomes 1 through 4. Reviewers evaluated Outcomes 1 (scientific inquiry is based on evidence) and 5 (Participate in scientific inquiry and communicate elements of the process) as being either emphasized (44% and 47%, respectively) or reinforced (24% and 12%, respectively) most frequently. Outcomes 2 (Recognize the scope and limits of science), 3 (Relationship between natural sciences and society), and 4 (Evaluate scientific information) were more often evaluated as introducing or reinforcing the concepts. It should be expected that introductory courses would primarily "introduce" or "reinforce" concepts. Of particular concern is that one-quarter of the courses did not appear to address at least one of the outcomes 2, 3, or 4. More than 10% of the lab assignments did not seem to address outcome 5. Figure 1 illustrates the results.

Figure 1. To what extent are the learning outcomes addressed in the course? (N=34)



*Outcome 5 was only required for lab sections (N= 22)
Note: Due to rounding, percentages may not sum to 100%

Student Work Samples

Course instructors were asked to submit the instructions for three course assignments, projects, or exams. From the three assignments, instructors selected one and provided corresponding samples of student work. The Office of Institutional Assessment chose 4-9 students for each section by random selection, and instructors submitted one work sample for each student. Many instructors chose to submit additional exemplars. A total of 89 work samples were collected from lecture courses, 168 work samples collected from laboratories, and two sets of exam scores were submitted. The work samples represented homework assignments, laboratory projects, and essays.

In comparing the student work samples with the assignment instructions, reviewers determined that the work samples from the lecture courses demonstrated the intended learning outcomes "completely" (38%) or "mostly" (40%), with another 18% rating "somewhat adequately", and only 1% "inadequately" (see Figure 2). When rating the work samples from the lab courses, reviewers determined the samples demonstrated learning outcomes "completely" (31%) or "mostly" (36%). Another 23% met the intended outcomes "somewhat adequately," while 3% were rated

"inadequately" and 3% were unable to be judged (see Figure 3). Overall, student work samples across both lab and lecture sections effectively demonstrated achievement of the intended learning outcomes.

Figure 2. How fully do the student work samples manifest the intended outcomes? (Lecture samples)

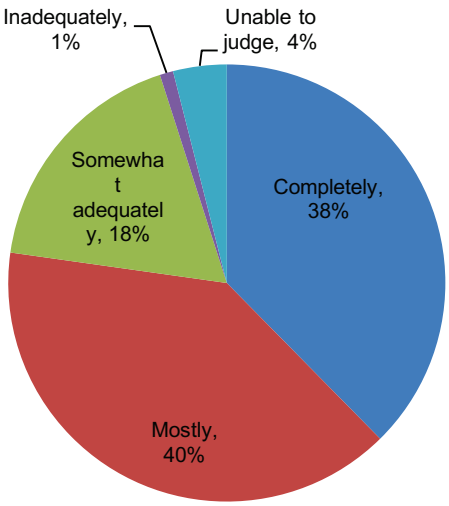
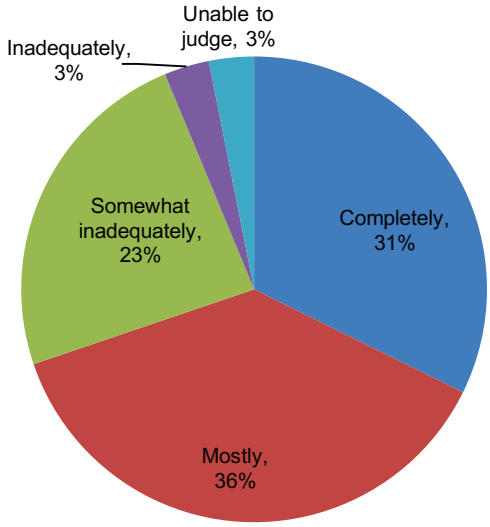


Figure 3. How fully do the student work samples manifest the intended outcomes? (Lab samples)



Overall Ratings

Course portfolios were rated holistically in five categories in relation to the Mason Core NS learning outcomes (see Figure 4). Courses were most likely to rate "outstanding" (53%) or "good" (32%) in terms of appropriateness of course material for the Mason Core curriculum, and course structures and procedures (38% "outstanding" and 35% "good"). Courses seemed to face the most challenges in articulating the learning outcomes to students (with 18% rated as "poor"), although the majority (61%) were rated as "outstanding" or "good." In terms of the overall effectiveness of the course in addressing the NS learning outcomes, 35% were rated "outstanding," 38% "good", 15% were rated "fair," and only 6% rated "poor" (see Figure 5). The NS courses rated quite highly overall.

Figure 4. Given the mission of the Mason Core program, please rate the course in the following categories:

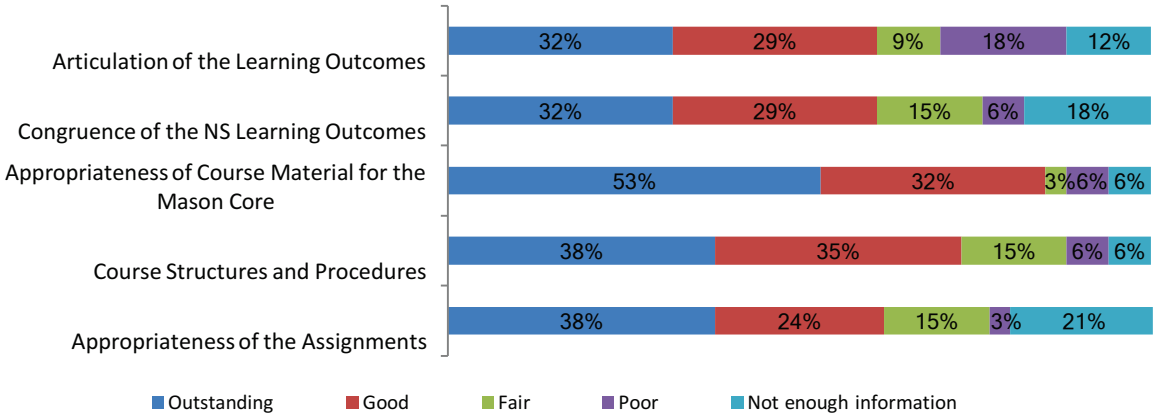
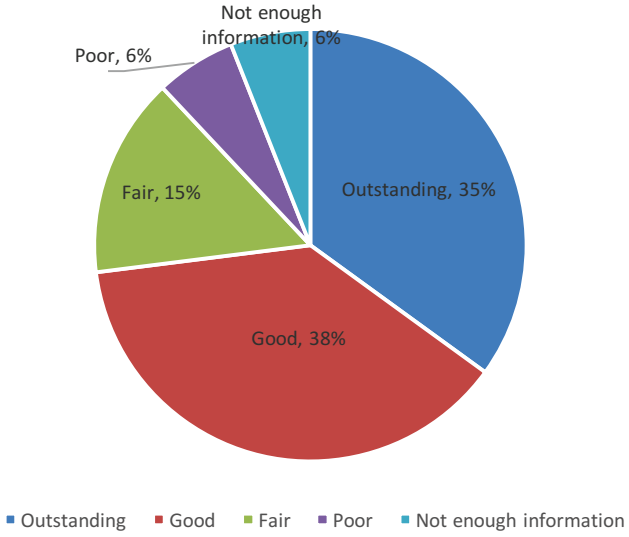


Figure 5. Overall effectiveness of the course in addressing NS learning outcomes



Summary of Faculty Narratives

A key component of the course portfolio is the narrative, in which faculty are asked to discuss their experiences in the course in regard to the student learning outcomes, student learning in the course, unexpected findings, and assessment of learning outcomes. The narrative is also expected to address the course context, challenges or issues, experimentation or changes that faculty implemented, and the results of those changes.

Overall, instructors thought it was helpful to work with the Mason Core learning outcomes while teaching the natural science courses. Many noted that the outcomes provided a structure on which to plan their learning activities, especially those for students who are not oriented towards the subject area (non-majors). Faculty reported that there was a range of student knowledge and experience with science, so they worked to encourage students' enthusiasm for science and facilitate deeper understanding of concepts and the scientific process. Many faculty members reported that students had attained a greater understanding and appreciation for science and the course concepts by the end of the semester.

Faculty employed a variety of activities to enhance student learning of the Mason Core outcomes. Many of the courses were large lecture courses with 100 or more students per section, so instructors often relied on multiple-choice exam scores. However, most instructors incorporated several other learning activities and assignments to complement the exams. Many noted that using a variety of methods helped students to be more involved and make a connection between the material and learning outcomes. For example, one instructor performed an in-class scientific experiment and asked students to develop their own hypotheses and then test their hypotheses. Other instructors noted that having class discussions (posing questions about experiments or data from experiments) and in-class activities (e.g., think-pair-share exercises, small group discussions, writing short reflection essays, drawing models of systems, in-class iclicker quizzes) helped to reinforce and emphasize concepts covered in lecture. One instructor gave bonus points for student participation, which allowed for the opportunity to practice in a low-stakes environment and increased the likelihood that students were prepared for class.

In addition to the main challenge of having a large class size, faculty faced several other challenges. Multiple faculty members noted that they struggled in addressing learning outcome 4 ("Evaluate scientific information [e.g., distinguish primary and secondary sources, assess credibility and validity of information]") due to the large class size. These faculty members noted that this was more easily addressed in the lab setting. Another challenge faculty noted was the difficulty in generating interest and enthusiasm in the course topics amongst non-majors. Through the use of a variety of active learning techniques and real world examples, instructors noted that students did show engagement and interest in the topics by the end of the semester. For science majors, instructors strived to help students deeply understand the concepts and the "dynamic nature of science" as opposed to memorizing facts for an exam. To achieve this goal, faculty implemented creative methods such as using anecdotes and animations to foster interest in the content, and asked students for feedback regarding their teaching strategies to gauge their effectiveness in conveying the learning outcomes.

In thinking about how to improve their courses, instructors had plans for future semesters, including the following:

- Continue to offer group learning activities and class discussion.
- Design a pre-course assessment to better assess incoming student knowledge.
- Incorporate more interactive activities and assignments. It was noted that a teaching assistant or learning assistant would be necessary to help with grading due to large class sizes.
- Consider grading course discussions to improve participation and attendance.
- From an online course instructor: encourage struggling students to meet in person with instructor.
- Promote more student discussion because debate is a helpful tool to encourage students to think more deeply about the issues.

Summary of Reviewers' Comments

Reviewers were asked to comment on features of the courses and provide recommendations. This section summarizes the reviewers' comments.

What elements/features from the course would you recommend to other faculty who teach NS courses?

- Reviewers praised the instructors' use of activities that encourage students to connect the course content with their own lives (e.g., a paper on mitigating the effects of climate change in Virginia and a homework assignment to relate climate temperature to your own household energy use).
- Faculty used a variety of creative activities (e.g., iclickers, at-home experiments) with clear connections to societal issues to allow students to practice and gain mastery over the topics.
- The books and reading materials faculty assigned were appropriate and, in some cases, "phenomenal learning tools."

- The assessments, assignments, and class discussions posed excellent questions to address the learning outcomes.

In terms of addressing the intended NS learning outcomes, what suggestions would you give to the faculty member?

- Faculty are asked to include the full Mason Core learning outcomes on the course syllabus, and not just the statement that the course meets a Mason Core requirement. The syllabus should also help students understand how the learning activities in the course map to the outcomes. Reviewers suggested that a "stronger connection" needs to be made between course activities and the learning outcomes.
- Faculty are encouraged to be thoughtful about how the course balances all of the learning outcomes, and make sure that the course is designed to help students meet all of them.
- Some reviewers suggested incorporating different types of activities (e.g., projects) or in-class activities (iclickers, in-class group work) into the course (instead of only using exams for assessment).
- Reviewers suggested incorporating as many memorable real world examples as possible (e.g., making ice cream for precipitation or flame test for properties of electron movement in a chemistry course) to improve student learning. Further, reviewers reaffirmed that making connections of course content to science and society more broadly is an essential part of the courses.
- It might be necessary for some lab sections to put more emphasis on how to generate and explain hypotheses and interpret/present data. In addition, it might be useful for students to have an opportunity to use authentic data in the labs.

General Comments:

- *I could tell that the instructor is very invested in the learning of her students based on the syllabus and the narrative provided in the portfolio.*
- *Ties biology to society to get students interested in science around them.*
- *There seem to be some discrepancy between the significant work done for the discipline specific learning outcomes and the almost invisible effort for the other learning outcomes. Maybe this calls for either a review of the outcomes or (better, in my opinion) a standardization of the way to measure the outcomes. Faculty are not aware of the implications and the opportunities of testing for learning outcomes.*
- *Though the professor was apologetic re: aligning her course assessments with gen ed learning outcomes, I think that her course does a good job of covering the learning outcomes.*
- Reviewers were concerned about assessing the courses without enough information (i.e., in some cases faculty did not provide all of the requested materials).

Follow-Up Actions

This report will be shared with participating instructors and department chairpersons to address the issues and concerns that were revealed in the assessment process. Course development resources will be made available to support instructors in their efforts to better align their courses with the Mason Core outcomes. Exemplars will be made available to the university community with instructor consent.

APPENDIX

Mason Core Natural Sciences Courses Fall 2013

Course	Title	Enrollment	% of Total Enrollment	# Portfolios
College of Science				
ASTR 103	Astronomy	100	2.02%	1
ASTR 111	Introductory Astr: Solar System	550	11.08%	1/1 NR
ASTR 302	Found of Cosmological Thought	21	0.42%	NA
BIOL 103	Introductory Biology I	709	14.29%	2
BIOL 104	Introductory Biology II	145	2.92%	1
BIOL 213	Cell Structure and Function	477	9.61%	2
CDS 101	Intro Computatnl/Data Sciences	4	0.08%	NA
CHEM 101	Introduct to Modern Chemistry	31	0.62%	NA
CHEM 103	Chem Sci in Mod Soc I	34	0.69%	NA
CHEM 211	General Chemistry	664	13.38%	1/1 NR
CHEM 212	General Chemistry II	120	2.42%	NA
CHEM 251	General Chem for Engineers	76	1.53%	1
CLIM 101	Glob Warm: Weather, Clim/Socie	57	1.15%	1
EVPP 110	Ecosphere: Environ Sci I	255	5.14%	1
EVPP 111	Ecosphere: Environ Sci II	112	2.26%	NA
EVPP 201	Env and You: Iss-21st Cent	6	0.12%	NA
GEOL 101	Introductory Geology I	265	5.34%	1
GEOL 102	Introductory Geology II	52	1.05%	1
GGS 102	Geography & Geoinformation Sci	70	1.41%	1
GGS 121	Dynamic Atmosphere/Hydrosphere	15	0.30%	NA
PHYS 103	Physics/Everyday Phenomena I	96	1.93%	NA
PHYS 160	University Physics I	189	3.81%	1 NR
PHYS 243	College Physics I	366	7.38%	1
PHYS 245	College Physics II	68	1.37%	NA
PHYS 260	University Physics II	126	2.54%	NA
PHYS 262	University Physics III	37	.07%	1 NR
College of Health and Human Services				
NUTR 295	Introduction to Nutrition	189	3.81%	2
University (Provost)				
UNIV 301	Natural Science Overview	128	2.58%	NA
	TOTAL	**4,962**	**100%**	**17**

"NA" = Course was not selected to produce a portfolio for this assessment cycle
"NR" = Portfolio was requested, but not received

GENERAL EDUCATION: NATURAL SCIENCE

The Mason Core natural science courses engage students in scientific exploration; foster their curiosity; enhance their enthusiasm for science; and enable them to apply scientific knowledge and reasoning to personal, professional and public decision making.

To achieve these goals, students will:

1. Understand how scientific inquiry is based on investigation of evidence from the natural world, and that scientific knowledge and understanding:
    a. Evolves based on new evidence
    b. Differs from personal and cultural beliefs
2. Recognize the scope and limits of science
3. Recognize and articulate the relationship between the natural sciences and society and the application of science to societal challenges (e.g., health, conservation, sustainability, energy, natural disasters, etc.)
4. Evaluate scientific information (e.g., distinguish primary and secondary sources, assess credibility and validity of information).
5. Participate in scientific inquiry and communicate the elements of the process, including:*
    a. Making careful and systematic observations
    b. Developing and testing a hypothesis
    c. Analyzing evidence
    d. Interpreting results

*Lab courses must meet all five of the above learning outcomes. Non-lab courses must meet learning outcomes 1-4.

Course:_____ **Reviewer:**_____

1. To what extent are the above learning outcomes addressed in the course?

	Instructor Intent (I, R, E)	Emphasizes Outcome	Reinforces Outcome	Introduces Outcome	Does not Address/ Not Apparent	Not Enough Information
Outcome 1		3	2	1	0	IN
Outcome 2		3	2	1	0	IN
Outcome 3		3	2	1	0	IN
Outcome 4		3	2	1	0	IN
Outcome 5		3	2	1	0	IN

"Introduces" (I) indicates that students are introduced to the concept.
"Reinforces" (R) indicates that students have some experience with the concept and have opportunities to practice.
"Emphasizes" (E) indicates that students have had sufficient practice and can now demonstrate mastery.

2. Evaluate the following based on the selected assignments and student work samples. Evidence may also be found in the syllabus, course map, and reflective statement. Do not re-grade student work.

Use the table below to answer the following questions:
a) Intended outcome(s) addressed in the selected assignment (Check all outcomes that apply under "Instructor Intent".)

b) To what extent does the assignment give students the opportunity to demonstrate their competence in the intended outcome(s)?

	Instructor Intent	To a Great Extent	Somewhat	Very Little	Not at All	Not Enough Information
Outcome 1		3	2	1	0	IN
Outcome 2		3	2	1	0	IN
Outcome 3		3	2	1	0	IN
Outcome 4		3	2	1	0	IN
Outcome 5		3	2	1	0	IN

c) How fully do the student work samples manifest the intended outcomes? (Ignore the instructor's grade and related comments.)

Student Name or Work Sample #	Completely	Mostly	Somewhat Adequately	Inadequately	Unable to Judge
Self-Selected Exemplar (optional)	4	3	2	1	☐
#1	4	3	2	1	☐
#2	4	3	2	1	☐
#3	4	3	2	1	☐
#4	4	3	2	1	☐
#5	4	3	2	1	☐
#6	4	3	2	1	☐

3. Given all available evidence, rate the course overall in the following categories:

	Outstanding	Good	Fair	Poor	Not enough info
Articulation of the general education learning outcomes for students	4	3	2	1	IN
Congruence of the general education learning outcomes with the course content and goals	4	3	2	1	IN
Appropriateness of course material for the Mason Core curriculum	4	3	2	1	IN
Course structures and procedures that contribute to the likely achievement of the Mason Core outcomes by students	4	3	2	1	IN
Appropriateness of the assignments or forms of assessment, in relation to the Mason Core learning outcomes	4	3	2	1	IN
Overall effectiveness of the course in addressing Mason Core learning outcomes	4	3	2	1	IN

4. What elements/features of the course would you recommend to other instructors?

5. In terms of addressing the Mason Core learning outcomes, what suggestions would you give to the instructor?

6. To what extent does the course portfolio demonstrate an exemplary Mason Core course?

❍ Definitely Yes ❍ Probably Yes ❍ Probably Not ❍ Definitely Not

7. Other comments about the course or the review process:

REVIEWING THE LAB

Use this section to review the associated lab only, using the lab assignments and samples.

Evaluate the next two items based on the selected LAB assignment and student work samples. Evidence may also be found in the syllabus, course map, and narrative statement. Do not re-grade student work.

1. To what extent does the assignment give students the opportunity to demonstrate their competence in the intended outcome?

	Instructor Intent	To a Great Extent	Somewhat	Very Little	Not at All	Not Enough Information
Outcome 5		3	2	1	0	IN

2. How fully do the student work samples for the LAB manifest the intended outcomes? (Ignore the instructor's grade and related comments.) Enter the number of samples that you rate in each category.

	To a Great Extent	Somewhat	Very Little	Not at All	Not Enough Information
Work Samples	3	2	1	0	IN

OVERALL COURSE RATINGS

	Outstanding	Good	Fair	Poor	Not enough info
Articulation of the general education learning outcomes for students	4	3	2	1	IN
Congruence of the general education learning outcomes with the course content and goals	4	3	2	1	IN
Appropriateness of course material for the general education curriculum	4	3	2	1	IN
Course structures and procedures that contribute to the likely achievement of the general education outcomes by students	4	3	2	1	IN
Appropriateness of the assignments or forms of assessment, in relation to the general education learning outcomes	4	3	2	1	IN
Overall effectiveness of the course in addressing general education learning outcomes	4	3	2	1	IN

1. In terms of addressing the general education learning outcomes, what suggestions would you give to the instructor?

2. To what extent does the course portfolio demonstrate an exemplary Mason Core course:

❍ Definitely Yes ❍ Probably Yes ❍ Probably Not ❍ Definitely Not

3. Other comments about the course or the review process: