Mason Core Rubrics for Natural Science Courses

Student Learning Activities Rubric for Lecture Courses

Learning Outcomes 1-4: METHODS, SCOPE AND LIMITS OF SCIENCE, SCIENCE AND SOCIETY, AND SCIENTIFIC LITERACY

How to use this rubric: This rubric describes the progression in understanding that students should demonstrate as they advance through Mason Core (general education) courses in the Natural Sciences. It is intended to provide guidance to faculty members designing courses and assessment tools and should not be viewed as establishing expectations for a certain level of achievement at the end of a single general education science course. Faculty members are encouraged to use the rubric to establish the level of understanding, for each component of knowledge, they would like to see students achieve in their course. For more information about the learning outcomes and approved courses, https://masoncore.gmu.edu/natural-science-lab-and-non-lab/

Student Learning Outcomes	Level of Performance			
	Advanced	**Proficient**	**Developing**	**Novice**
SCIENTIFIC METHOD: Understand how scientific inquiry is based on investigation of evidence from the natural world, and that scientific knowledge and understanding: • evolves based on new evidence • differs from personal and cultural beliefs	Demonstrates understanding of the scientific method by formulating questions about nature; articulates the relationship between evidence and theory, how these are used to build an argument.	Demonstrates understanding of how the scientific method is implemented; describes the relationship between evidence and theory and how the two are used to build an argument.	Articulates the relationship between evidence and theory in a simplistic way; provides limited explanation of how the two are used to build an argument.	Shows minimal understanding of the difference between evidence/data and explanation/theory.
SCOPE AND LIMITS OF SCIENCE: Recognize the scope and limits of science (see notes on page 3)	Clearly articulates the scientific issue/problem, explains how it fits within the discipline's sphere of inquiry, and describes multiple approaches to addressing it.	Clearly identifies and describes the scientific issue/problem; demonstrates general understanding of how it fits within discipline's sphere of inquiry.	Identifies the issue/ problem; offers simplistic explanation of how it fits within discipline's sphere of inquiry.	Unable to identify the issue/problem; demonstrates little or no understanding of discipline's sphere of inquiry.

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Student Learning Outcomes	Level of Performance			
	Advanced	**Proficient**	**Developing**	**Novice**
SCIENCE AND SOCIETY: Recognize and articulate the relationship between the natural sciences and society and the application of science to societal challenges	Skillfully evaluates the relationship between scientific and/or technological issues and developments to humans and issues of societal concern and articulates the ramifications of such issues and developments.	Identifies relationships between scientific and/or technological issues and developments to humans and issues of societal concern; discussion of these issues shows increasing sophistication.	Begins to recognize relationships between scientific and/or technological issues and developments to humans and issues of societal concern; discussion of these issues is simplistic.	Offers limited ability to recognize relationships between scientific and/or technological issues and developments to humans and issues of societal concern.
SCIENTIFIC LITERACY: Evaluate scientific information (e.g., distinguish primary and secondary sources, assess credibility and validity of information)	Consistently uses appropriate criteria to evaluate the quality of the scientific information and determine the credibility of the evidence based on its source, relevance to the research question, and methods used to generate it, with a critical eye to authority and bias.	Uses generally appropriate criteria to evaluate the quality of the scientific information and determine the credibility of the evidence based on its source, relevance to the research question, and methods used to generate it.	Recognizes appropriate strategies to evaluate the quality of the scientific information or data. Selects sources using basic criteria, such as relevance to the research question.	Chooses few to no strategies to evaluate the quality of the scientific information or data. Selects sources using limited or unclear criteria.

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Notes on the Scope and Limits of Science

Defining the Boundaries of Science and Scientific Inquiry

The scope and limits of science define the boundaries of what questions science is equipped to address. Science deals with questions of the physical world. The scientific method addresses questions for which a hypothesis is testable and falsifiable, and experiments and observations are repeatable. Science can address important questions, make predictions, and create useful technologies. Science tells us how the world is.

Modern science can address many questions and solve many problems, but there are limits to its reach. Areas of limitations include questions about value, questions of morality, questions about the supernatural, and questions about "ultimate reality."[1] Science reaches its limits at questions such as: What is beauty? How should a problem be solved? What are ethical solutions? What are moral actions? What is our purpose in the world? Science does not tell us how to use scientific knowledge.

Seven aspects of the Nature of Science that define science as a discipline[2]:

1. Scientific knowledge is subject to change.
2. Knowledge is empirically based.
3. Knowledge is theory laden and subjective.
4. Knowledge is the product of human imagination and creativity.
5. Knowledge involves the combination of observation and inferences.
6. Laws and theories play an important role in developing new ideas.
7. Scientific ideas are validated by repetition and peer review.

[1] Uko, C. J. (2010). Limitations of modern science. Retrieved from: https://www.researchgate.net/publication/215777806_LIMITATIONS_OF_MODERN_SCIENCE

[2] Schwartz, R. S., Lederman, N. G., and Crawford, B. A. (2004). Developing views of nature of science in an authentic context: An explicit approach to bridging the gap between nature of science and scientific inquiry. *Science Education, 88*, 610-645.

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Lab Reports Rubric

Learning Outcome 5: SCIENTIFIC INQUIRY

Laboratory sections in the Mason Core are designed to support students to achieve the following outcome with five sub outcomes listed in column one.

Students will participate in scientific inquiry and communicate the elements of the process, including:

Student Learning Outcomes	Level of Performance			
	Advanced	**Proficient**	**Developing**	**Novice**
5a. Make careful and systematic observations	Data/observations are accurately recorded. All representations of data/observations are clear, complete, and appropriate for the scientific information collected.	Data/observations are recorded with minor errors. Representations of data/observations are mostly clear, complete, and appropriate for the scientific information collected.	Data/observations are recorded with some errors. Representations of data/observations are inconsistently clear, complete, and appropriate for the scientific information collected.	Data/observations are recorded with significant errors. Representations of data/observations are mostly unclear, incomplete, or inappropriate for the scientific information collected.
5b. Develop a hypothesis	Presents multiple relevant, testable hypotheses as appropriate to the questions; connection between hypothesis and the scientific issue is clear and insightfully and fully integrates the appropriate scientific concepts.	Hypothesis is relevant and testable; connection between hypothesis and scientific issue is clear and derives from valid scientific concepts.	Hypothesis is stated; connection between hypothesis and scientific issue is stated and appears to be derived from valid scientific concepts; however, some confusion between hypotheses and predictions.	Hypothesis is missing or unrelated to the scientific question; scientific concepts are not used or are incorporated inaccurately.
5b. Test a hypothesis	Method is well documented, including sufficient detail so that experiment can be easily repeated.	Method is generally well documented, including enough detail to repeat the experiment.	Method is documented but some procedural steps are missing so that not enough details are provided to repeat the experiment.	Method is incomplete, unclear, or not described.

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5c. Analyze evidence	Analysis is thorough and insightful and goes beyond the obvious connections to demonstrate complete grasp of relevant course concepts.	Analysis is accurate and makes obvious connections to relevant course concepts.	Analysis is general and shows limited or superficial linkage to appropriate course concepts.	Analysis is fundamentally flawed or absent.
5d. Interpret results	Summarizes results correctly. Conclusions are accurate and insightfully link results to both the relevant scientific concepts and the original hypotheses and predictions.	Summarizes results correctly with few errors. Conclusions are accurate and include all aspects of the results. Connections to hypothesis and predictions are clear and accurate, if somewhat simplistic.	Summarizes results correctly with some errors. Conclusions are simplistic but not seriously flawed. Makes connections to the original hypothesis or predictions but misses some obvious relationships.	Summarizes results with errors. Conclusions are overly simplistic, absent, or flawed. Interpretation of findings is limited or missing.

Language for both rubrics was adapted from the following sources:

- Association of American Colleges and Universities. Information Literacy VALUE Rubric. Retrieved from: https://www.aacu.org/value-rubrics
- Delaware State University. General Education – Natural Science Rubric and SLO. Retrieved from: https://www.desu.edu/academics/student-success/services/general-education
- New Mexico Statewide General Education Steering Committee. Draft Rubrics for Assessment of Learning Outcomes for General Education Courses: Content Area: Science. Retrieved from: https://www.nmt.edu/academicaffairs/assessment/Appendix_D_gen_ed_rubrics.pdf
- University of Nevada, Reno. Assessment of Core Curriculum. Retrieved from: https://www.unr.edu/assessment/core