General Education Assessment: Spring 2014
Scientific Reasoning

Introduction
Students will demonstrate an understanding of scientific principles and apply them to theoretical and practical issues, and interpret measurable and/or observable information through inference and analogy to develop hypotheses and draw conclusions.

There are six general SLOs associated with Scientific Reasoning (SR):

- Students can describe methods of scientific inquiry and apply them to investigating, questioning and solving problems. (Sci. Meth.)
- Students can describe and carry out experimental procedures. (Exp. Pro.)
- Students can perform laboratory tasks appropriate to the field. (Lab Tasks)
- Students can interpret and communicate scientific information using written, oral and/or graphical means. (Int./Comm.)
- Students can describe and analyze one or more relationships among science, technology and society and demonstrate an understanding of scientific applications in everyday life. (Rel./Apps.)
- Students can demonstrate logical reasoning in explaining natural phenomena, experimental procedures or outcomes, and/or application of scientific or technological concepts. (Log. Reason)

For the assessment of these outcomes, a rubric was developed by the SR subcommittee of the general education work group (Appendix A).

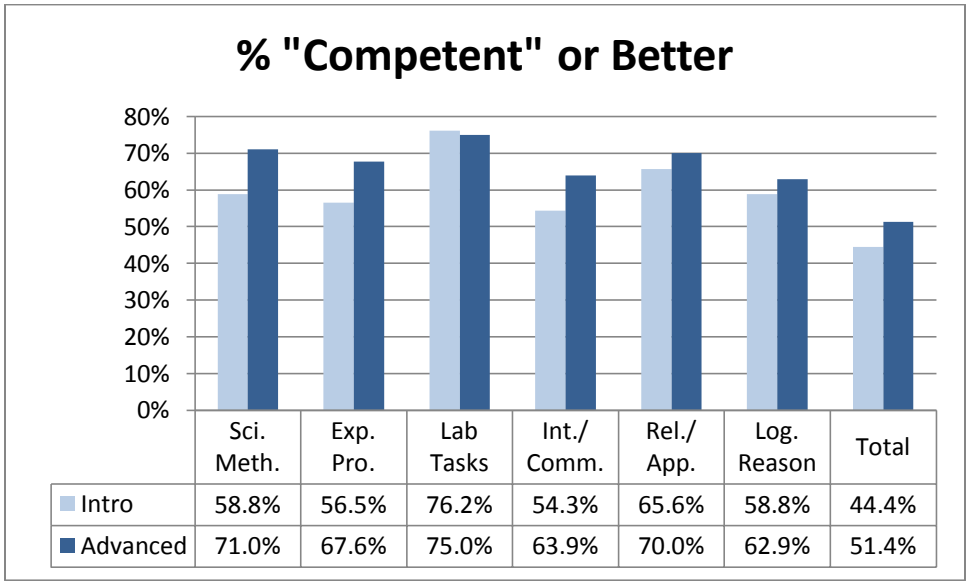
Methods
In Spring 2014, two students were randomly selected from each faculty member teaching a course that met the College's Natural Science requirement.[1] In total 184 students were selected. Emails were sent to these students informing them of their selection. Faculty received emails asking them to participate in a survey version of the rubric. Students were evaluated on a Likert Scale from 1 (Beginning) to 4 (Accomplished). There were ninety three (93) responses, eighty seven (87) of which were unique and sixty five (65) of which were usable. For analysis, students were divided into two groups: those enrolled in courses with no science pre-requisites (e.g. BIOL 106, PHYS 108) ["Intro"], and those with a science pre-requisite (e.g. CHEM 122) ["Advanced"]. Two types of comparisons were performed: the averages for students in each group and percent of students in each group who were ranked as at least Competent (3).

Results
In all cases, at least half of the students performed at the competent (3) or higher (Figure 1). Differences between those in introductory and advanced courses were generally small. Despite this, in all but one of the assessed outcomes (Laboratory Tasks) students averaged below "competent" (Figure 2).

In all but Laboratory Tasks, a higher percentage of students in advanced courses assessed "competent" than those in introductory courses. For both groups, however, more than half of students were judged competent in all areas.

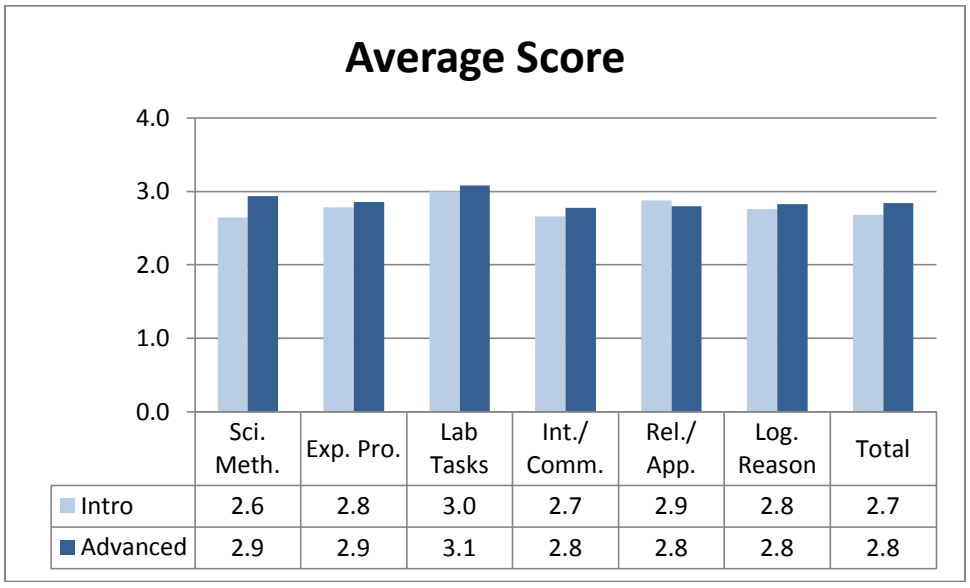
[1] A course that fulfills the Natural Science requirement is a college-level course, designed to use the scientific method to understand and describe the natural world. Natural sciences include biology, chemistry, earth science, physics and multi-disciplinary courses such as Science, Technology and Society. Any course from Biology, Chemistry, Earth Science, Physics, ASET, or STS meets this requirement.

Figure 1. Percent of Students ranked “Competent” or higher



	Sci. Meth.	Exp. Pro.	Lab Tasks	Int./ Comm.	Rel./ App.	Log. Reason	Total
Intro	58.8%	56.5%	76.2%	54.3%	65.6%	58.8%	44.4%
Advanced	71.0%	67.6%	75.0%	63.9%	70.0%	62.9%	51.4%

Figure 2. Average Score on each SLO



	Sci. Meth.	Exp. Pro.	Lab Tasks	Int./ Comm.	Rel./ App.	Log. Reason	Total
Intro	2.6	2.8	3.0	2.7	2.9	2.8	2.7
Advanced	2.9	2.9	3.1	2.8	2.8	2.8	2.8

Indirect Evidence

Currently there are no indirect reports from institutional research that address success in scientific reasoning. Science programs, however, are very active in completing their program and course SLOs (and Chemistry and Biology were noted in the Middle States Report for their efforts).

Conclusions and Recommendations

- On the whole, students are performing near a level of competence.
- For most part SLOs are being achieved by students, as seen in departmental assessments.
- On individual metrics, between half and three-quarters of students are competent.
- Students in advanced courses perform slightly better than those in introductory courses.

1. The general education requirement claims that students will be able to "perform laboratory tasks appropriate to the field." However, no lab course is required for graduation. Several surveyed faculty mentioned that they were unable to answer that question appropriately. It is recommended that a decision needs to be made whether a lab requirement is necessary or if the requirement should be changed.

2. Closer examination of the requirements and whether courses are meeting the actual objectives of the general education requirements seem warranted. Although program and courses SLOs are being met, students are only marginally performing on the general education requirements. Additional courses seem to only increase students' competence marginally indicating that requiring multiple courses will not necessarily improve student performance.

3. An additional exam from Madison Assessment is still in progress (not enough students have completed it yet); information from this should also be considered when this assessment is completed.

4. Scientific Reasoning should be evaluated again in three years.

Appendix A: Scientific Reasoning Rubric

Scientific Reasoning Rubric

Skills	Beginning (1)	Developing (2)	Competent (3)	Accomplished (4)
Student can describe methods of scientific inquiry and apply them to investigating, questioning and solving problems	The student cannot:	The student can:	The student can:	The student can:
	Identify a scientific problem	Identify and clearly state a scientific problem	Restate the scientific problem in a question format	Develop a proper research question
	Recognize that problems have solutions	Select one possible solution to the problem	Predict one or more possible solutions to the problem	Evaluate alternate solutions to the problem
	Recognize the definition of an hypothesis	Select a hypothesis appropriate to the problem	Generate a testable hypothesis appropriate to the problem	Propose how to evaluate a hypothesis appropriate to the problem
Student can describe and carry out experimental procedures.	The student **cannot:**	The student can:	The student can:	The student can:
	Recognize the purpose/ objective of an experiment	State the purpose/ objective of the experiment in their own words	State the purpose/ objective of the experiment in their own words	Explain the purpose/ objective of the experiment in their own words
	Determine the materials needed to complete the experimental procedure	Determine the materials needed to complete the procedure	Determine the materials needed to complete the procedure	Determine the materials needed to complete the procedure
	Recognize experimental variables	Differentiate between independent and dependent variables	Differentiate between independent, dependent, and confounding variables and controls	Select the experimental variables and controls
			Describe the relationship between the experimental steps	Manipulate the experimental variables and controls
				Suggest modifications of the experimental design, as appropriate
Student can perform laboratory tasks appropriate to the field.	The student **cannot:**	The student can, with frequent reminders:	The student can independently:	The student takes initiative to:
	Obey safety rules and handle lab equipment safely	Obey safety rules and handle lab equipment safely	Obey safety rules and carefully handle lab equipment	Obey safety rules and carefully handle lab equipment
	Follow written procedures	Follow written procedures accurately	Follow written procedures accurately	Follow written procedures accurately
	Identify scientific tools appropriate to the task	Employ scientific tools with proper technique	Employ scientific tools with proper technique	Employ scientific tools with proper technique
	Work independently	Measure and record data	Measure and record data with minimal errors	Measure and record data accurately

Student can interpret and communicate scientific information using written, oral and/or graphical means	The student **cannot:**	The student can:	The student can, with few errors:	The student can, with few to no errors:
	Interpret quantitative information from tables and graphs using basic vocabulary	Interpret quantitative information from tables and graphs using vocabulary appropriate to the discipline	Interpret quantitative information from tables and graphs results using technical vocabulary	Accurately interpret quantitative information using highly technical vocabulary and make appropriate inferences
		Construct data tables and represent information graphically	Independently construct data tables and represent information graphically.	Independently construct data tables and represent information graphically
			Communicate experimental or investigative results	Clearly communicate experimental or investigative results
				Draw logical conclusions from collected data
Student can describe and analyze one or more relationships among science, technology and society and demonstrate an understanding of scientific applications in everyday life	The student **cannot:**	The student can:	The student can:	The student can:
	Identify a technological breakthrough and its connection to science	Identify a technological breakthrough and its connection to science	Identify a technological breakthrough and its connection to science	Identify a technological breakthrough and its connection to science
		Place a technological breakthrough in an historical context	Place a technological breakthrough in an historical context	Place a technological breakthrough in an historical context
		Explain some of its impacts on society	Explain some of its impacts on society	Explain and analyze some of its impacts on society
			Explain one or more scientific principles behind a technology	Explain one or more scientific principles behind a technology
				Describe examples or possible future developments related to science, technology and society
Student can demonstrate logical reasoning in explaining natural phenomena, experimental procedures or outcomes, and/or application of scientific or technological concepts.	The student struggles to:	The student can:	The student can:	The student can:
	Identify logical explanations for observed phenomena	Identify logical explanations for observed phenomena	Identify possible alternative logical explanations for observed phenomena	Develop possible alternative logical explanations for observed phenomena
		Identify fallacies or illogical conclusions based on observations	Identify fallacies or illogical conclusions based on observations or data	Describe fallacies or illogical conclusions based on observations or data
				Evaluate claims based on observation, experimentation or data presented