

General Education Assessment: Spring 2017

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 skills associated with Scientific Reasoning (SR):

- Students can describe methods of scientific inquiry and apply them to investigating, questioning and solving problems. (Scientific Method)
- Students can describe and carry out experimental procedures. (Experiment)
- Students can perform laboratory tasks appropriate to the field. (Lab Skills)
- Students can interpret and communicate scientific information using written, oral and/or graphical means. (Interpret)
- Students can describe and analyze one or more relationships among science, technology and society and demonstrate an understanding of scientific applications in everyday life. (Applications)
- Students can demonstrate logical reasoning in explaining natural phenomena, experimental procedures or outcomes, and/or application of scientific or technological concepts. (Reasoning)

For the assessment of these outcomes, a rubric was developed by the SR subcommittee of the general education work group in 2009 (Appendix A). Each rubric articulates 3 – 5 criteria for each of the six skills.

Method

Faculty teaching a course with no pre-requisites that met the College's Natural Science requirement were asked to assess three students on their competency in this area. Courses with no pre-requisites were selected because the College requires only one Natural Science course for graduation, therefore competency should be attained without taking multiple courses. Faculty were asked to complete the assessment without adding any additional assignments to the course syllabus. As the assessment was intended to be summative (evaluating student learning at the end of the course), faculty were asked to complete the assessment no earlier than the 11th week of the semester. Faculty contributed assessments for 118 students, 57 of which were usable. These included 6 Business and Technology, 24 Liberal Studies, and 27 Math, Science, Health majors.

Table 1. Course Distribution

| | Complete |
|--|-----------|
| CHEM 121 College Chemistry | 3 |
| PHYS 111 General Physics I | 2 |
| PHYS 140 Mechanics, Heat and Sound | 2 |
| EASC 111 Environmental Conservation | 1 |
| BIOL 109 Anat & Phys I | 9 |
| CHEM 110 Introductory Chemistry | 6 |
| BIOL 106 General Biology I | 5 |
| PHYS 125 Musical Acoustics | 1 |
| CHEM 101 General Chemistry | 4 |
| STS 101 Intro To Sci,Tech,Society | 2 |
| BIOL 104 Forensic Biology | 2 |
| ASET 101 Science, Tech & Public Policy | 2 |
| CHEM 105 Inquiry into Chemistry | 1 |
| BIOL 107 General Biology II | 1 |
| Grand Total | 41 |

Table 2. Student Distribution

| Major Desc | BT | LS | MSH |
|--------------------------------|----------|-----------|-----------|
| Accounting | 1 | | |
| Behavioral Health/Human Serv | | 2 | |
| Biology | | | 5 |
| Business Administration | 3 | | |
| Chemistry | | | 1 |
| Comp Info Sys/Information T.. | 1 | | |
| Computer Science | 1 | | |
| Digital Forensics | | 1 | |
| Ed Early Child-birth-4th grade | | 4 | |
| Engineering Science | | | 6 |
| English | | 1 | |
| Health Care Studies | | | 15 |
| International Studies | | 1 | |
| Justice | | 2 | |
| Lib Arts/Honors Option | | 3 | |
| Liberal Arts | | 6 | |
| Photographic Imaging | | 1 | |
| Psychology | | 2 | |
| Sound Recording & Music Te.. | | 1 | |
| Grand Total | 6 | 24 | 27 |

Results

Most students achieved competency in each of the six skill sets; with over 70% of students achieving competency in Scientific Method, Lab Skills, and Interpretation. This is an improvement in the percentage of students achieving competency as reported in 2014.

Chart 1. Percentage of Students by Score - 2017; Reference Line: Benchmark at 75%

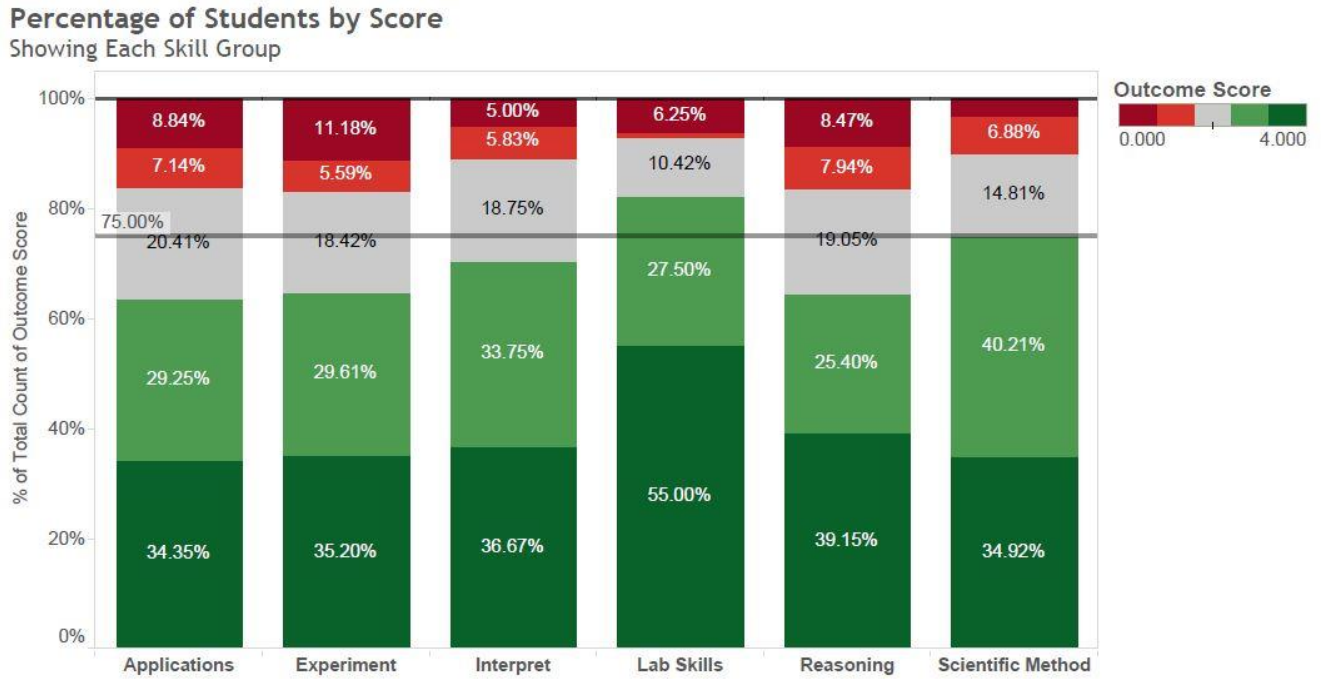
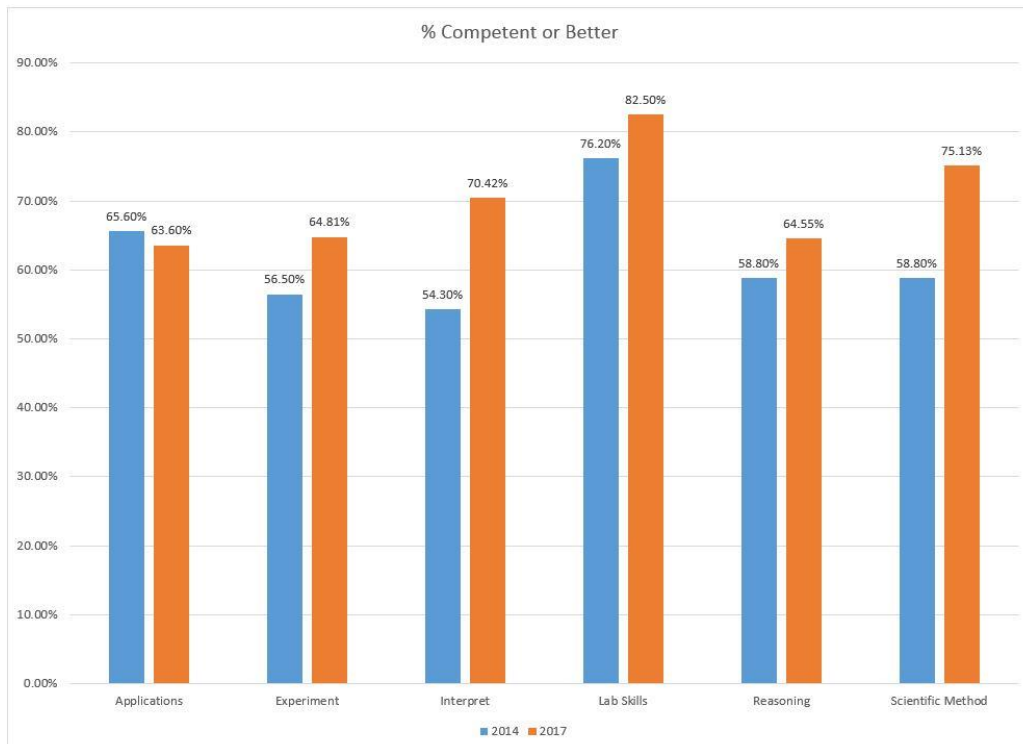


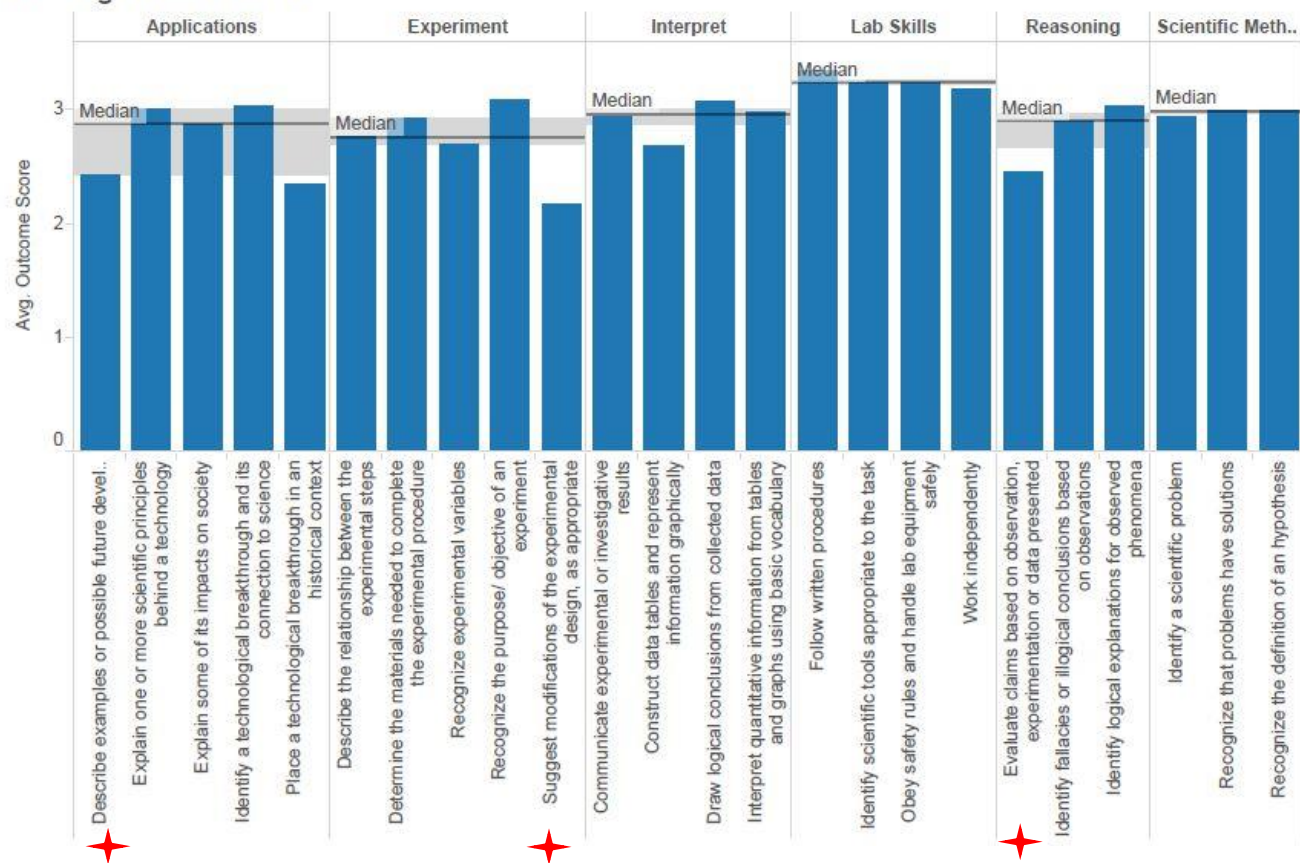
Chart 2. Percentage of Students scored as Competent (3); Comparison 2014 to 2017



Faculty identified a few higher-order criteria on the rubric which would be achieved only by *Accomplished* students (Appendix A). Evaluation of each skill by rubric criteria shows that, indeed, a lower average score is achieved in these criteria:

Chart 3. Average Outcome Scores by Skill; Showing Rubric Criteria

**Average Outcome Scores by Skill
Showing Rubric Criteria**



In the 2014 survey recommendations, it was noted that several faculty responders mentioned challenges in assessing “Lab Skills.” The 2014 report noted that, as a Lab Science was not required for all majors, faculty should discuss whether the criteria should be included as a General Education competency. In the 2017 survey, faculty were asked whether each skill they were asked to assess was appropriate to the course.

The 2017 results did not indicate that faculty found, “Lab Skills,” to be inapplicable more often than other skills. In this survey, ‘Experimental Procedures,’ and ‘Applications,’ were both more likely to be listed by faculty as “not applicable to this course.”

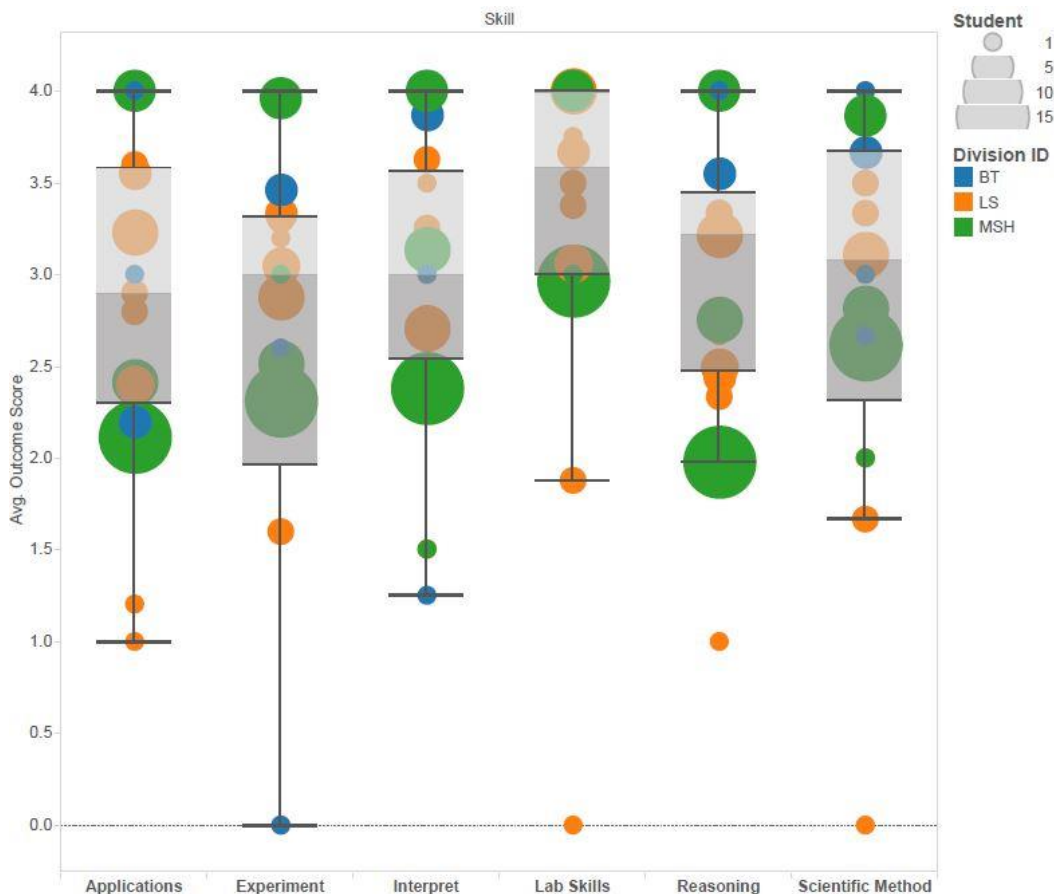
The General Education Review Committee may want to further examine the relationship of course learning outcomes to competency skills in their next review to ensure that competencies are relevant to course design.

Table 3. Skills not Applicable to this Course

| Skill | Description | N/A |
|--------------------------------|---|-----|
| Scientific Inquiry | Student can describe methods of scientific inquiry and apply them to investigating, questioning and solving problems | 2 |
| Experimental Procedures | Student can describe and carry out experimental procedures. | 5 |
| Laboratory Skills | Student can perform laboratory tasks appropriate to the field. | 3 |
| Communicate | Student can interpret and communicate scientific information using written, oral and/or graphical means | 2 |
| Applications | Student can describe and analyze one or more relationships among science, technology and society and demonstrate an understanding of scientific applications in everyday life | 6 |
| Logical Reasoning | Student can demonstrate logical reasoning in explaining natural phenomena, experimental procedures or outcomes, and/or application of scientific or technological concepts. | 0 |

When scores are distributed by major, and coded by size and division, the Business and Technology majors cluster mostly in the upper range; Liberal Studies almost uniformly within the score averages; and Math, Science and Technology majors split at the top and at the bottom of the range.

Chart 4. Average Score Distributed by Major; Coded by Size and Division



Conclusions and Proposals

Findings

- Most students are achieving competency in Scientific Reasoning.
- “Understanding scientific applications in everyday life...” had the lowest percentage of students achieving competency, and was most likely to be listed as, “not applicable to this course.”
- ‘Applications,’ criteria also had one of the lowest average criteria score; the lowest score amongst fundamental skills.¹

Assessment Practice

Outcomes Improvement: Focus on *Applications Skill*

In evaluation of student’s ability to understand, “scientific applications in everyday life,” a common strategy is to ask students to evaluate examples of scientific journalism within contemporary media. A bank of similarly worded questions, representing a variety of content areas, can ensure faculty’s ability to easily contribute to the competency assessment. Questions from the Question Bank can be added to a faculty member’s existing quiz or exam. To ensure that the question is evaluating Scientific Reasoning, as opposed to reading comprehension, it is important to establish a consistent reading level or primary source. For example, “select materials from an 8th grade reading level,” or, “select materials from *The Philadelphia Inquirer*.”

General Education Review Committee:

The committee should review faculty survey and ‘higher order’ criteria to ensure that the rubric is an appropriate and applicable tool to evaluate the General Education Competency in courses meeting the student’s Natural Science requirement.

Benchmark:

75% of students should score ‘Competent’ in all skill areas when Scientific Reasoning is next assessed in three years.

¹ When ‘higher-order’ rubric skills are removed from evaluation, “Place a technological breakthrough in historical context,” shows the lowest average rubric score.