Seaver College General Education Assessment
Academic Year 2011-2012

I. Program Learning Outcome

Scientific Reasoning: Use the scientific method to investigate the natural or physical world

II. Institutional Educational Objectives

Laboratory science is one of 14 General Education (GE) program learning outcomes in the undergraduate school (Seaver College) at Pepperdine University. Seaver College offers a liberal arts education that includes both a broad GE and a focus in a subdivision of knowledge needed for specialized professions. The GE model at Seaver College is dissemination and integration; such that, students fulfill GE curriculum learning outcomes in courses designed specifically for the GE program an in courses within their chosen majors. In the case of the GE learning outcome for *Scientific Reasoning*, students enrolled in Seaver College achieve this learning outcome through specific courses designated as a GE Laboratory Science.

The GE curriculum advances the mission, objectives, and institutional educational objectives (IEO) of Pepperdine University. In this context, the major objectives of Pepperdine University are formed by two components: core commitments and institutional values. The core commitments of the university are *knowledge and scholarship*, *faith and heritage*, and *community and global understanding*. Each commitment is implemented and evaluated through the lens of the institutional values of purpose, service, and leadership. The Institutional Educational Objectives and their relationship to the GE program learning outcomes are shown in the tables below. The *Scientific Reasoning* GE learning outcome fulfills IEOs #1, #4, and #7:

Institutional Educational Objectives

	Knowledge/ Scholarship	**Faith/ Heritage**	**Community/Global Understanding**
PURPOSE	**IEO#1** Demonstrate expertise in an academic or professional discipline, display proficiency in the discipline, and engage in the process of academic discovery.	**IEO#2** Appreciate the complex relationship between faith, learning, and practice.	**IEO#3** Develop and enact a compelling personal and professional vision that values diversity.
SERVICE	**IEO#4** Apply knowledge to real-world challenges.	**IEO#5** Respond to the call to serve others.	**IEO#6** Demonstrate commitment to service and civic engagement.
LEADERSHIP	**IEO#7** Think critically and creatively, communicate clearly, and act with integrity.	**IEO#8** Practice responsible conduct and allow decisions and directions to be informed by a value-centered life.	**IEO#9** Use global and local leadership opportunities in pursuit of justice.

GE Learning Outcomes	IEO#1	IEO#2	IEO#3	IEO#4	IEO#5	IEO#6	IEO#7	IEO#8	IEO#9
Critical Thinking	✓	✓		✓			✓	✓	
Quantitative Reasoning				✓			✓		
Scientific Reasoning	✓			✓			✓		
Oral Communication							✓		
Written Communication							✓		
Human Response to Art	✓	✓			✓			✓	
Human Response to Literature	✓	✓			✓			✓	
Christianity & Culture		✓		✓	✓	✓		✓	✓
American Experience			✓	✓		✓			✓
Foreign Language			✓	✓			✓		
Human Institutions & Behavior		✓	✓	✓	✓		✓	✓	
Western Heritage			✓						
Nonwestern Heritage			✓						
Research & Inquiry	✓								

The IEOs are representative of the comprehensive mission of Pepperdine University; therefore, the specific alignment of these IEOs to the curriculum of the GE program illustrated the integrality of the GE curriculum in advancing the Mission of the University.

III. Student Learning Outcome

SLO #1	***Laboratory Science (Scientific Method)*** Through laboratory science, students will demonstrate the ability to identify the basic components of the scientific method and/or distinguish between facts and inference through application of the scientific method.

The primary objective of scientific research is to provide a materialistic explanation for natural phenomena through observation and experimentation. Scientific inquiry involves discovery and the testing of hypotheses with the acquisition of empirical data, both qualitative and quantitative. Science progresses by following a protocol, designed to enhance objectivity. This protocol is known as the scientific method, which is designed to test falsifiable predictions derived from specific models developed to explain various phenomena.

There are five basic components to the scientific method. These include: 1) establishment of a goal or objective for a particular study; 2) proposal of a model or abstract explanation that makes specific testable predictions or inferences; 3) observation and data collection used to test a specific model; 4) an evaluation of a specific model by direct comparison to observations and data collection; and 5) rejection or revision of the model in light of the comparisons made. Models can be of various types. For instance**, abstract models** may be in the form of a hypothesis, such as cellular telephones increase the risk of brain cancer. Other types of abstract models include theories, mathematics models, and computer models. Two other types of models are **physical and sampling models**. Physical models include organisms, properties of organisms, structures, pictures, and replicas. For instance, the food pyramid is a physical model that emphasizes the ingredients required for a healthy diet. Another type of physical model is the laboratory mouse, which serves as a surrogate for experiments designed to investigate human diseases. Sampling models relate to the treatment of data. For instance, the selection of samples for a particular experiment might be either random or blind, and samples might be subdivided into controls and experimental groups.

IV. Curriculum Map

The laboratory science general education learning outcome is met by various courses within the Natural Science Division of Seaver College. Some of these courses satisfy a lower-division prerequisite for science majors, while others serve only the GE curriculum (i.e., non-science majors). It is expected that within each of the courses listed here, the laboratory science learning outcome will be introduced, developed, and mastered at a level appropriate for both the general education curriculum goals as well as the course level (upper- or lower-division) itself. GE laboratory science is required of science and non-science majors alike. There are courses that fulfill *only* the GE laboratory science requirement. There are courses offered within the curriculum of a science major that fulfills the GE laboratory science requirement. For this reason, most science majors do not take a GE science course outside of the requirements in their major (one of the courses in each science major will meet the laboratory science requirement). The 2011-2012 Academic Calendar states:

Laboratory Science (4)
This laboratory-based requirement demonstrates the applicability of science to everyday life. Students are introduced to the methods used by scientists to investigate and understand the natural world and are taught to assess the reliability and limitations of those methods.

> ***Courses fulfilling the laboratory science requirement*** *(recommended for the general student): BIOL 105, BIOL 106, BIOL 107, BIOL 108, BIOL 109, NASC 101, NASC 108, NASC 109, NASC 155, NASC 156, NUTR 210, SPME 106. These major-specific courses also satisfy the requirement: BIOL/SPME 230, BIOL/SPME 270, CHEM 120, PHYS 202, PHYS 210.*

V. Assessment Plan

	Direct Evidence	Indirect Evidence	Authentic Evidence
SLO #1	See specific course listings below	None	None

Lab Science Courses – Natural Science Division

	Course	**Instructor**	***Direct Evidence***	***Assessment Tool***	2011 2012	2012 2013
SLO #1 Students will demonstrate the ability to identify the basic components of the scientific method and/or distinguish between facts and inference through application of the scientific method.						
	BIOL 108	Nofziger Plank	Specified exam questions Selections from lab notebook Pseudoscience Assignment Genetic Technology Debates	NASC Rubric	✓	
	BIOL 109	Welday	Practical exam (evaluation of original research)	NASC Rubric	✓	
	BIOL 270	Jasperse	Group discussions Case studies related to scientific method Laboratory exercise	NASC Rubric	✓	
	CHEM 120	Fritsch	Review of lab practical exams	NASC Rubric	✓	
	PHYS 202	Henisey		NASC Rubric	✓	
	SPME 106	Nelson	Specified assignment pertaining to the scientific method	Modified Rubric	✓	
	NASC 109	Fasel	Creating a journal	NASC Rubric	✓	
	NUTR 210	Delano	Practical exam over original research	NASC Rubric	✓	
	NUTR 210	Helm	Practical exam over original research	NASC Rubric	✓	
	GE Science Courses offered in International Programs					
	NASC 109	Armstrong				✓
	SPME 106	Giacobassi				✓
	BIOL 107	Zhong				✓
	NASC 101	Davis, S	Field notebook, exams, reading reports	NASC Rubric	✓	

VI. Rubric

SCIENTIFIC THINKING *Achievement of skill* *GE achievement of skill*	*Knowledge Creation* **4** *Capstone* *Very high*	*Knowledge Deepening* **3** *Milestone* *Milestone (High)*	*Knowledge Acquisition* **2** *Benchmark* *Milestone (Moderate)*	*Knowledge Acquisition* **1** *Benchmark* *Benchmark*
I. Background information, statement of problem, hypothesis formation	Accurately identifies the problem/question and provides a well-developed summary of the problem. Statements and hypothesis(es) are contextual, evidence-based, clear/concise, and appropriate in scope.	Accurately identifies the problem/question and provides a brief summary; introduction complete but either unclear or poorly organized in places.	Identifies the problem/question and provides a poor summary or is inaccurate in identification of problem/question.	Failure to clearly and/or accurately define the problem/question; poor or lacking organization.
II. Experimental procedure, identification and/or application of method/model	Method/model properly identified, described, and/or applied. Details are provided in a sequential manner and include a complete account of materials used and analyses performed.	Method/model reasonably identified and/or not completely described. Some elements are unorganized or missing.	Somewhat incomplete description of method/model. Provides an account of the experimental procedures but key elements are unclear or missing.	Misidentification or incomplete/unclear description of the model; failure to list important aspects of the experimentation.
III. Results of methods/models	Thorough account of results (e.g., inclusion of tables/figures), excellent and accurate presentation of data/analysis(es).	Missing few details of the results, lacks creativity in presentation of data/analysis(es).	Merely lists of provides an incomplete report of data/results.	Provides an inaccurate or inadequate identification of data/results.
IV. Conclusions, implications, and consequences	Accurately identifies and/or develops evidence-based conclusions with a well-developed explanation. Provides objective reflection of own assertions and a creative assessment.	Accurately identifies and/or develops conclusions with a brief evaluative summary; distinguishes between fact and opinion but is somewhat lacking in reflection and creativity.	Does not thoroughly explain, provides some misinformation, or only provides a list of ideas or limits evaluation to discussion of one area.	Provides an inaccurate or inadequate report of conclusions.
	Higher Order Thinking Skills			**Lower Order Thinking Skills**
Thinking skills associated with level of learning	4 *Designing, constructing, planning, producing, inventing, devising, making, evaluating, checking, hypothesizing, critiquing, experimenting, judging testing, detecting, monitoring*	3 *Analyzing, comparing, organizing, deconstructing, attributing, outlining, finding, structuring, integrating, applying,implementing, carrying out, using, executing*	2 *Understanding, interpreting, summarizing, inferring, paraphrasing, classifying, comparing, explaining, exemplifying*	1 *Remembering, recognizing, listing, describing, identifying, retrieving, naming, locating, finding*
Communication Spectrum	*Collaborating, moderating, negotiating, debating, commenting*	*Meeting, reviewing, questioning, replying, posting & blogging*	*Networking, contributing, chatting, e-mailing, texting*	

VII. Criteria/Benchmarks for Student Achievement/Success

The Natural Science Division in Seaver College at Pepperdine University developed a rubric for the assessment of laboratory science GE and adapted as needed to suit specific assignments and/or course terminology. The rubric, included in this report utilizes a scale of 1-4 to indicate various levels of achievement in the four basic steps of the scientific method (or scientific way of thinking). As no external benchmarks exist to aid in the establishment of criteria indicating appropriate levels of student learning in *laboratory science,* all members of the Natural Science faculty have agreed on the following expectant levels of achievement:

SCIENTIFIC THINKING	*Knowledge Creation*	*Knowledge Deepening*	*Knowledge Acquisition*	*Knowledge Acquisition*
	4	**3**	**2**	**1**
Achievement of skill	***Capstone***	***Milestone***	***Benchmark***	***Benchmark***
GE achievement of skill	***Very high***	***Milestone (High)***	***Milestone (Moderate)***	***Benchmark***

VIII. Evidence / Data

DIRECT EVIDENCE

In the academic year 2011-2012, the Natural Science Division on the Malibu campus assessed nine separate courses that meet the GE laboratory science requirement. The full assessment of the laboratory science learning outcome is included here in the example of PHYS 202 (Physics I). The table provided here is a summary of all courses that assessed the laboratory science GE learning outcome this academic year, based on the NASC scientific method rubric or other closely related rubric:

Laboratory Science Courses – AY 2011-2012

Course	**Instructor**	***Sample Size***	***Fulfills Science Major Req***	***Meets or Exceeds Benchmark 2***	***Does Not Meet Benchmark***	**Average Level of Student Achievement***
BIOL 108	Nofziger Plank	20	GE only	100%	0%	2.5
BIOL 109	Welday	15	GE only	100%	0%	2.7
NASC 109	Fasel	25	GE only	100%	0%	?
NUTR 210	Helm	28	✓	75%	25%	3.0
NUTR 210	Delano	32	✓	75%	25%	3.0
SPME 106	Nelson	40	GE only	100%	0%	?
BIOL 270	Jasperse	38	✓	100%	0%	3.7
CHEM 120	Fritsch	18	✓	83%	17%	2.5
PHYS 202	Henisey	32	✓	100%	0%	3.5
NASC 101 (London)	Davis	14	GE only	100%	0%	2.5

* This average is for students assessed using the NASC rubric.

EXAMPLE ASSESSMENT

General Education - Program Learning Outcome
Laboratory Science, Natural Science Division

In the current academic year (2011-2012), PHYS 202 was used to assess the GE learning outcome of laboratory science (scientific method).

I. Learning Outcome

Students will demonstrate the ability to identify the basic components of the scientific method and/or distinguish between facts and inference through application of the scientific method.

II. Direct Evidence

I assessed the above learning outcome using a small group, independent research project focused loosely on the physics of California. After identifying an environmental phenomena, biological process, or technological process relevant to their experience as Californians and tied to the group members' personal interests, students formulate a relevant and physically-motivated mathematical model designed to predict the outcome of a controlled experiment. Over the course of several weeks, the group then carries out this experiment and compares their collected data with their model's predictions. Students lastly draw conclusions about the applicability of their model to the broader topic motivating the investigation, presenting their information both in the form of a written research paper and an oral presentation. This assessment focuses solely on students' written submissions. The reader may find the assignment's instructions in Appendix A and a represent set of submissions along with their individual assessments in Appendix C.

III. Assessment and Grading Rubrics

I assessed student achievement in scientific reasoning by applying the standardized rubric for scientific thinking established by the Natural Science Division (hereafter, "assessment rubric") to a representative selection of student submissions. Section IV aggregates the achievements of these samples while section V comments on these results in the context of the expected learning outcome. Samples and their accompanying rubrics can be found in Appendix C.

However, for grading purposes, I utilized the rubric by which I score student laboratory reports throughout the semester (hereafter, "grading rubric"). This provides greater continuity and a better assessment of progression during the term. This rubric can be found in Appendix B.

IV. Assessment Results

Figure 1 shows the number of students with project reports scores in 2 point bins, Fall 2011 represented by blue, Spring 2012 by red, and the combined populations by the dotted lines. Scores are based on the grading rubric found in Appendix B. The following table provides basic statistics from these distributions.

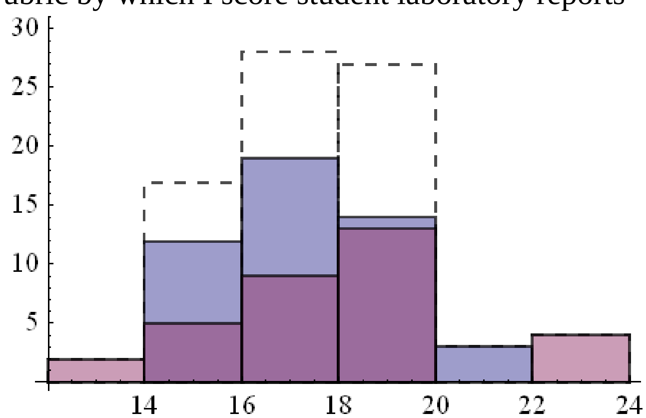


Figure 1 – Student project scores in 2 point bins for Fall 2011 (blue), Spring 2012 (red), and the total set (dotted).

	Fall 2011	Spring 2012	Combined
Median	17.5	18.5	17.5
Mean	17.1	17.9	17.4
Standard Dev.	1.4	2.6	2.0

To understand these grades in the context of assessing our above learning outcome, I apply the assessment rubric to a representative sample of student project reports. Seven sample reports make up this assessment, four from the Fall 2011 term and three from Spring 2012, each included in Appendix C. The first four reports were taken from the Fall 2011 class, scored 12.5, 18, 18, and 24 points on the grading rubric, respectively, and represent roughly the lowest, median, and highest achieving works. Likewise, the remaining three reports were taken from the Spring 2012 class, scored 12, 18.5, and 22 points on the grading rubric, respectively, and again represent the lowest, median, and highest achieving works. Although a report scoring roughly 18 or more points strongly meets my course expectations, I believe a lower score may nonetheless meet the GE laboratory science learning outcome.

The highest achieving reports from the two semesters demonstrated a strong understanding of the scientific method. By scoring predominantly in the “3” and “4” columns of the assessment rubric, students clearly organize scientific information and understand the interplay between experimental methods, numerical data and scientific hypotheses. In general, the authors fall short of mastery only when evaluating their conclusions within the context of the broader topic. That is, after an introduction, which effectively motivates a controlled experiment and a physical model (or at least an investigation into various potential models), both reports seem to relate their bottom line findings back to their opening discussions in only a rudimentary way. This aside, both assignments align exceptionally well with the desired learning outcome: each clearly identifies the connection between experimentation and quantitative modeling that is at the heart of the scientific method.

Reports achieving roughly median scores from both terms exhibit a basic understanding of the scientific method. In each of these three reports, students scored characteristically in the “3” column of the assessment rubric with only roughly one achievement skill rated in the “2” column. Our median students successfully apply each component of the scientific method within their study. They often see beyond the individual pieces to a more integrated understanding of the method. Each then demonstrates a developing skill at synthesizing reasonable scientific conclusions from their experimental and analytical work. These evidence an appropriate alignment with our learning outcome.

EXAMPLE ASSESSMENT

Lastly, student work at the lowest levels of achievement shows, at the very least, a minimal understanding of some aspects of the scientific method. Each report earns scores in the “2” column of the assessment rubric in at least three of the four achievement skills. In both cases, the authors successfully identify some aspects of an appropriate physical model or develop at least the makings of an experimental method. However, each ultimately fails to work out one or more component of the scientific method and is unable to draw substantive conclusions beyond their initial inferences. Of course, this assessment attests only to these students’ baseline level of understanding. I strongly suspect some lack of effort likely contributed to their low achievement, particularly in the development of a legitimate experimental procedure. Therefore, although their work may not identify the true achievement of these students, it at least indicates a rudimentary familiarity with the scientific method and development toward the learning outcome.

As a final comment, the quality of thought and creativity in the “off-sequence,” Spring 2012 cohort is markedly lower than that of the Fall 2011 group. Unfortunately, I did not reflect these differences in my application of the grading rubric as a way of compensating for slightly different expectations. However, I speculate that the disparity in quality arises for three reasons. First, I was significantly more hands-on with the Fall students in terms of intermediate deadlines and scheduling. These students, therefore, began thinking about their project as much as two to three weeks earlier. Second, the Spring term had a significantly younger demographic, that is, the majority of student are sophomores rather than juniors. Certainly students mature in both scientific reasoning and time management throughout their undergraduate careers, and this progression may be visible between these two populations. Lastly, students perhaps enroll in the “off-sequence” because they advanced more slowly toward the completion of the requisite calculus coursework. This likely creates a selection effect that biases the Spring term toward students with weaker math backgrounds.

V. Conclusions

The seven selected student reports from the 2011-2012 Physics 202 trace the minimum, median, and maximum achievement of the learning outcome across both terms. As representative elements then, these samples indicate that the bulk of our Physics 202 students can effectively apply components of the scientific method and are actively developing the skills necessary to integrate these components to synthesize meaningful conclusions. Furthermore, it appears that no student leaves this course without at least a rudimentary ability to identify aspects of the scientific method as prescribed by the learning outcome. Numerically, at least 56% of Physics 202 students meet the learning outcome by achieving on average at the “milestone” or “3” column level; likewise, 100% of the Physics 202 students meet the learning outcome by achieving on average at the “benchmark” or “2” column level. I therefore believe that Physics 202 meets or exceed its aims as a GE laboratory science course.

This success aside, a look into the course demographic from the past year, raises two concerns. The following table breaks down the two terms’ enrollments based on the student year:

Term	Freshmen	Sophomores	Juniors	Seniors
Fall 2011	0	4	23	23
Spring 2012	3	12	11	6

Clearly the fall term is dominated by students taking Physics in the later stages of their undergraduate education. My first concern for this group then is that, if the GE science courses are to explore the practical application of the scientific method, these students might be learning scientific reasoning skills too late to be useful in their major curricula. On the other hand, my second concern is that, although Physics 202 students achieve their learning goals at a somewhat higher level than expected, as juniors and seniors, they should perhaps have progressed even further toward mastery than the language of the learning outcome suggests. As indicated in section IV, these older students did, in fact, perform better than their younger, Spring-term counterparts, but other the confounding factors make it difficult to say which of the two concerns is more pressing. In either case, the faculty may wish to discuss the temporal placement of this course within the major curricula from a practical perspective.

END OF EXAMPLE ASSESSMENT (PHYS 202)

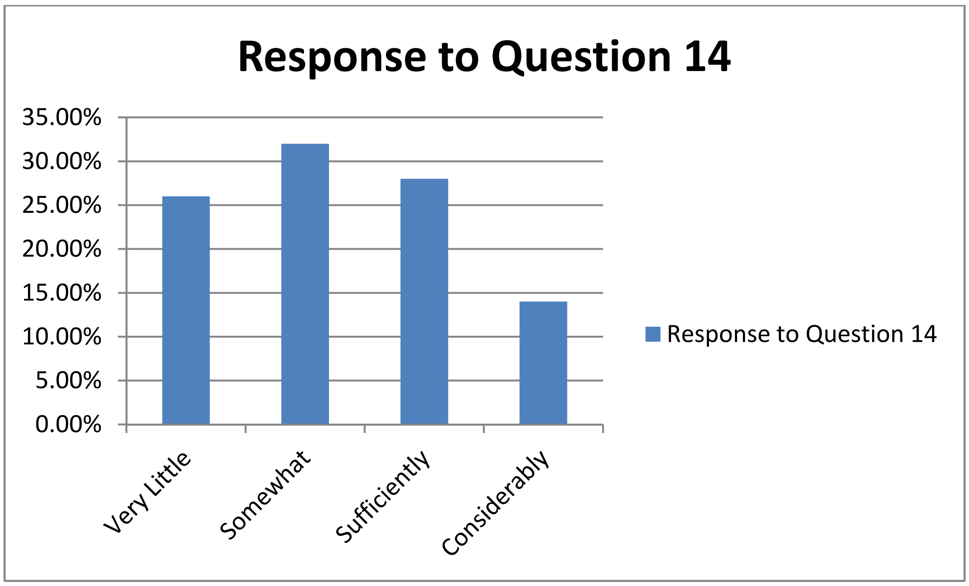
INDIRECT EVIDENCE

Graduating seniors were asked, by survey, how the general education curriculum contributed to their knowledge, skills and personal development in the outcomes targeted within the GE curriculum. The following is a table of the responses across all areas:

How has the General Education curriculum contributed to your knowledge, skills and personal development in the following areas?					
Answer Options	Very Little	Somewhat	Sufficiently	Considerably	Response Count
1. Careful reading: Comprehension and analysis of written texts within and across genres.	32	84	124	32	272
2. Critical thinking: Examination of ideas, evidence, and assumptions before accepting or formulating a conclusion.	22	79	108	63	272
3. Creative thinking: Developing or combining ideas, images, or expertise in innovative ways.	44	88	95	45	272
4. Information literacy: Locating, evaluating, and using information effectively and responsibly for a particular purpose.	25	80	123	42	270
5.Effective writing: Conveying accurate and compelling content in clear, expressive, and audience- appropriate prose.	30	73	116	53	272
6.Effective speaking: Conveying accurate and compelling content in clear, expressive, and audience- appropriate oral presentations.	31	73	111	56	271
7.Teamwork: Contributing to a team, facilitating the work of team members, and fostering a constructive team climate.	66	76	94	35	271
8.Problem solving: Designing, evaluating and implementing a strategy to answer questions or achieve a goal.	56	79	95	41	271
9. Civic engagement: Promoting the quality of life in a community, through both political and non-political processes.	66	89	85	32	272
10.Intercultural knowledge and competence: Information, skills, and commitments that support effective and appropriate interactions in a variety of cultural contexts.	38	75	110	48	271
11. Ethical reasoning: Recognizing ethical issues, examining different ethical perspectives, and considering the ramification of alternative actions.	32	73	113	53	271
12. Integrative thinking: The habit of connecting ideas and experiences, and the ability to transfer learning to novel situations.	27	73	117	54	271
13. Quantitative Reasoning: Explain math concepts, solve quantitative problems, and understand empirical data.	73	80	83	36	272
14. Science: The scientific method and the natural and physical worlds.	**70**	**87**	**76**	**38**	**271**
15. The Arts: The historical, cultural or technical significance of music, theater or art.	33	63	109	66	271
16. Literature: The ability to read, interpret and understand literature.	26	76	107	61	270
17. Christianity: Christian Scripture and the use of Scripture to evaluate the ethical and religious dimensions of contemporary society and culture.	37	54	105	76	272

18. American Experience: The political and historical developments that shaped America's diverse society.	35	64	116	57	272
19. Foreign Language: The ability to read, speak, listen and write in a non-English language.	37	54	103	76	270
20. Human Institutions & Behavior: The disciplines of economics, psychology and sociology and how they inform institutional and human behavior.	28	71	110	63	272
21. Western culture: The history, literature, philosophy and artistic achievements of western civilizations.	29	60	108	75	272
22. Nonwestern Culture: The history, literature, philosophy and artistic traditions of civilizations outside western civilizations.	35	70	103	63	271
				answered question	272
				skipped question	43

A total of 271 students provided a response to question 14, which is related to the scientific method and the natural world. Over 50% of the students responded either "very little" (26%) or "somewhat" (32%), whereas only 14% said considerably and 28% indicated sufficiently (Figure Below).



IX. Summary

Is our current GE lab science program successful at educating non-majors? - Currently, the GE requirements at Seaver College include 4 units of a "Laboratory Science" course, which is taught through the Natural Science Division. This requirement is considerably less than seen at other peer institutions, and it presents a challenge in terms of offering a course in science that is comprehensive enough to provide students with a reasonable educational experience in the sciences. Nevertheless, the Natural Science Division offers a smorgasbord of courses that meet the basic GE requirement including: BIOL 105 (Introduction to Marine Biology), BIOL 106 (Principles of Biology), BIOL 107 (Plants and the Environment), BIOL 108 (Genetics and Human Affairs), BIOL 109 (Introduction to Animal Behavior), CHEM 120 and 120L (General Chemistry), NASC 101 (Science As a Way of Knowing), NASC 108 (Beginning Geology), NASC 109 (Introduction to Astronomy), NASC 155 (Physical Science: A Way of Knowing), NASC 156 (Earth Science: A Way of Knowing), NUTR

(Contemporary Issues in Nutrition), PHYS 202 (Basic Physics), PHYS 210 (Physics I), SPME 106 (Introduction to Human Anatomy and Physiology), SPME 108 (Scientific Foundations of Sports Performance), SPME 230 or BIOL 230 (Human Anatomy), SPME 270 or BIOL 270 (Principles of Human Physiology). Although CHEM 120, PHYS 202, PHYS 210, SPME 230, and SPME 270 are listed as GE in the catalogue, the majority of students taking these courses are majors in the Natural Science Division. Based on a survey of enrollment in GE courses offered between 2008 and 2012, the most heavily subscribed courses are NUTR 210 and SPME 106 (Figure). Enrollment in SPME 230, SPME 270, and CHEM 120 reflect requirements for the Sports Medicine and Biology majors.

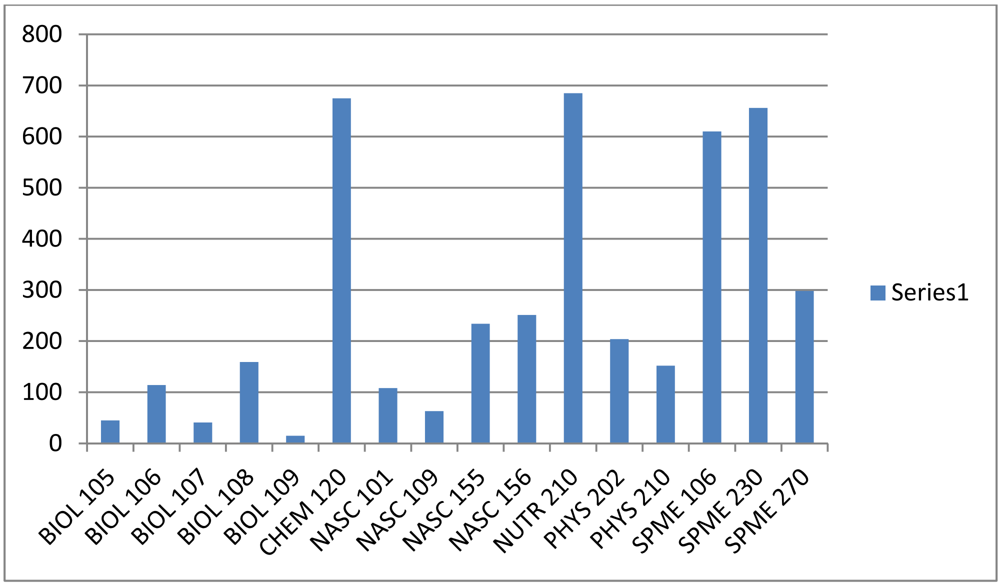


Figure. Summary of Enrollment in GE courses between 2008 and 2012

Why are more non-majors enrolling in NUTR 210 and SPME 106? There is more than one explanation for this result. First, these courses are probably offered on a more regular basis, and in the case of NUTR 210, multiple sections are offered. Second, non-majors often avoid "hard science" courses such as Biology, Chemistry, and Physics. We view these results as somewhat problematic, primarily because our non-majors are actually acquiring a limited amount of knowledge about science. Clearly, all of our current GE offerings fall short of providing breadth of knowledge as it relates to science. It is true that based on our GE assessment, students have reached a minimum level of understanding relative to the scientific method. At the same time, assessments that were more detailed revealed limits in both student interest and understanding. Indirect evidence from the survey of graduating seniors tends to support this finding.

Here are some interesting excerpts from a few of these assessments:

(1) *BIOL 101 (London) – "In some ways the students did learn at the anticipated level, in other ways they did not meet anticipated levels. One* <u>*disadvantage*</u> *of science courses being taught at our International Programs is that typically a well-equipped laboratory is not available, thus students are not able to experience the scientific process first hand. That is, they are not able to generate hypotheses that are empirically testable in an experimental lab, collect and analyze data, and draw conclusions."*

(2) *NUTR 210 – "Based upon our initial results, it appears that only about half of our students clearly understand the application of the scientific method. It is the expectation that 90-100% of our students will gain an understanding of the basic components of the scientific method and its' application, and this was not achieved with an average percentage score of 75%." "The range within the scores is wide, as expected. Some of the students mastered the concept while others demonstrated a lack of a "complete" understanding of scientific method."*

Based on the results of the senior survey on the GE curriculum, second the quantitative reasoning, graduating students scored scientific reasoning the lowest among 22 areas of skills and knowledge. The results of this survey backup the irregularities of the direct evidence and provide further impetus for a closer evaluation of the GE Lab Science curriculum.

X. Recommendations (Closing the Loop)

Long range goals for GE lab science curriculum – Although each GE course taught during the spring semester of 2012 assessed knowledge of the scientific method, it is not clear whether in one GE lab science course taught in our division that non-majors leave with a clear understanding of or appreciation for the enterprise of science. This is somewhat problematic because scientific thinking/enterprise will touch each of their lives on a daily basis regardless of their chosen vocation. As a result, we feel that faculty in the Natural Science Division involved in the GE curriculum should discuss ways to make the overall GE lab science courses more meaningful.

Assessment of GE lab science courses offered as study abroad – Only one study abroad science course (BIOL 101 in London) was assessed this year. GE lab science courses offered at a diversity of study abroad program are hard to properly assess. In many cases, local professors teach these GE courses, and proper evaluation of the quality of courses and student learning is **not** easy to execute. Therefore, it is our intention to communicate with each professor teaching a lab science course in the study abroad program, and as part of that communication, we will emphasize the need for an effective laboratory experience. More importantly, we will not support any lab science courses in the study abroad program that are not accomplishing the goals set for the GE lab science program.

Currently, two of the study abroad programs (London and Argentina) will begin offering both CHEM 310 and 311 (Organic Chemistry) and PHY 202 and 203 (General Physics). These courses are required for many of our majors in the Natural Science Division. In both cases, we coordinated the selection of appropriate instructors and the procurement of necessary laboratory facilities. We feel that the same care should be used in the coordination of GE lab science courses, especially since non-majors only have to take 4 units of lab science.

Coordination of proper GE assessment – Although all professors teaching GE courses during the spring of 2012 were provided a copy of the rubric and assessment protocol to be used, reporting of information varied in quality and content. Therefore, it was difficult to clearly evaluate the overall level of student learning as it relates to the scientific method. It does appear that at least the majority of students demonstrated “moderate” learning in terms of understanding the scientific method. Nevertheless, we need to do a better of job of acquiring quantitative information that is consistent across the courses offered. We will attempt to do initiate this in the coming fall semester.

XI. Contributors

Committee Members	Position Title	Academic Division
Rodney Honeycutt	University Professor and Chair, Natural Science Division	Natural Science
Cooker Perkins	Assistant Professor III, Sports Medicine	Natural Science
Shane Naki	Undergraduate	Natural Science

APPENDICES

Appendix A - Assessment Details

The following assessment was used to assess Student Learning Outcome #____.
Click here to enter text.

{Repeat and edit the above text as necessary for each assessment tool.}

Appendix B - Rubrics

The following rubric was developed by the Natural Science Division as a tool to be used across disciplines in the assessment of Scientific Reasoning

SCIENTIFIC THINKING *Achievement of skill* *GE achievement of skill*	*Knowledge Creation* **4** *Capstone* *Very high*	*Knowledge Deepening* **3** *Milestone* *Milestone (High)*	*Knowledge Acquisition* **2** *Benchmark* *Milestone (Moderate)*	*Knowledge Acquisition* **1** *Benchmark* *Benchmark*
I. Background information, statement of problem, hypothesis formation	Accurately identifies the problem/question and provides a well-developed summary of the problem. Statements and hypothesis(es) are contextual, evidence-based, clear/concise, and appropriate in scope.	Accurately identifies the problem/question and provides a brief summary; introduction complete but either unclear or poorly organized in places.	Identifies the problem/question and provides a poor summary or is inaccurate in identification of problem/question.	Failure to clearly and/or accurately define the problem/question; poor or lacking organization.
II. Experimental procedure, identification and/or application of method/model	Method/model properly identified, described, and/or applied. Details are provided in a sequential manner and include a complete account of materials used and analyses performed.	Method/model reasonably identified and/or not completely described. Some elements are unorganized or missing.	Somewhat incomplete description of method/model. Provides an account of the experimental procedures but key elements are unclear or missing.	Misidentification or incomplete/unclear description of the model; failure to list important aspects of the experimentation.
III. Results of methods/models	Thorough account of results (e.g., inclusion of tables/figures), excellent and accurate presentation of data/analysis(es).	Missing few details of the results, lacks creativity in presentation of data/analysis(es).	Merely lists of provides an incomplete report of data/results.	Provides an inaccurate or inadequate identification of data/results.
IV. Conclusions, implications, and consequences	Accurately identifies and/or develops evidence-based conclusions with a well-developed explanation. Provides objective reflection of own assertions and a creative assessment.	Accurately identifies and/or develops conclusions with a brief evaluative summary; distinguishes between fact and opinion but is somewhat lacking in reflection and creativity.	Does not thoroughly explain, provides some misinformation, or only provides a list of ideas or limits evaluation to discussion of one area.	Provides an inaccurate or inadequate report of conclusions.
	Higher Order Thinking Skills			**Lower Order Thinking Skills**
	4	3	2	1
Thinking skills associated with level of learning	*Designing, constructing, planning, producing, inventing, devising, making, evaluating, checking, hypothesizing, critiquing, experimenting, judging testing, detecting, monitoring*	*Analyzing, comparing, organizing, deconstructing, attributing, outlining, finding, structuring, integrating, applying,implementing, carrying out, using, executing*	*Understanding, interpreting, summarizing, inferring, paraphrasing, classifying, comparing, explaining, exemplifying*	*Remembering, recognizing, listing, describing, identifying, retrieving, naming, locating, finding*
Communication Spectrum	*Collaborating, moderating, negotiating, debating, commenting*	*Meeting, reviewing, questioning, replying, posting & blogging*	*Networking, contributing, chatting, e-mailing, texting*	

Appendix C - Evidence /Data (Optional)

The following evidence was gathered in assessment of Student Learning Outcome #____.

{Repeat and edit the above text as necessary for each SLO.}

Appendix D - Chronology

Date	Members Participating (Initials)	Action
Fall 2011	AD, MF, CF, CP	Established meta-outcomes for general education curriculum
Fall 2011	AD, MF, CF, CP	Established meta-outcomes for general education curriculum
Fall 2011	RH, CP	Division meeting to discuss assessment of Lab Science GE
Jan 2012	RH, CP	Established rubric for scientific reasoning
Jan 2012	RH, CP	Distribution of assessment rubric
Apr 2012	RH, CP	Data collection
May 2012	RH, CP	Data collection & first draft of assessment report
May 18, 2012	RH, CP	Submission of GE Lab Science assessment report