Assessment of program SLO’s for physical science

Bakersfield College, Fall 2009

Introduction

Our primary goals in this semester’s assessment activity are to continue to evaluate the efficacy of our approaches to teaching the established desired outcomes of our departments, and to establish within each discipline an understanding of how the desired outcomes mesh with the current approaches used in the classroom.

An additional goal outside of the actual assessment itself is to continue to push for the acceptance of the format presented here as an alternative to the current standard forms method used in other departments. One size does not fit all, and as a multifaceted department it is much simpler to keep individual courses separated. The work on any one individual ins minimized, while the result is something very easy to read. All that is needed is a good understanding of the full nature of the reporting required—each person can then mold their report to that norm.

Summary

The learning outcome chosen for study was program outcome #1: “Demonstrate a knowledge of and recognize the processes that explain natural phenomena.” Some instructors have begun assessing other outcomes as well.

Generally, a reasonable majority of students should successfully complete the assessment for positive acceptance of the method and outcome results (about two-thirds at a C level or better). Falling short of this should stimulate discussion leading to improvements in presentation of content and/or validity of assessment techniques and goals. It is understood that no single failure in a series of tests ordains such examination, but a majority would.

Faculty were asked to provide a summary of their findings, followed by more specifics regarding the individual assessments made, as needed. These works constitute the bulk of this document.

Overall it can be seen that our work is successful.

Changes and/or additions

The reports following are quite different from each other in their approach. Understanding better what would work as an outline will help normalize this, though keeping some freedom in expression will help people approach their work more willingly.

Adjunct faculty continue to be outside the loop in this work. While the department chair (me) asked others to follow through with people teaching their courses, the responsibility falls squarely on my shoulders for this. I need to set aside the time for getting those people on board. A few have sent in work, but that has not been incorporated here as the results are not as complete.

We have learned that evidence is not necessary for any purpose outside of our own discussions. In a sense this is a pleasant change since we won’t wind up with stacks of paper in the corners over the years.

People have been told that we should now expand our evaluations into the course level SLO’s. Of course, what is chosen for the larger program studies fall naturally into these slots as well, so a suggestion will be made to the group as a whole to eye points which overlap both as suitable for study.
Astronomy–Fall 2009

Nick Strobel

Here are my results for our assessment of department SLO #1, #2, #3. I think our goal for this last term was department SLO #1 (knowledge of processes). What I did: Each class was given an anonymous pre-test at the very beginning of the first day of the semester with 12 questions. Those same questions were asked in the final exams. The survey astronomy class (Astr B1 Physics of the Cosmos) and the solar system class (Astr B3 Solar System) were given the same pre-test. Five questions fit SLO #1, five questions fit SLO #2, and five questions fit SLO #3 (some questions fit multiple SLOs).

Results

SLO #1 (knowledge of processes)

On the five questions for this SLO, 10%, 30%, 6%, 20%, and 27% got them correct on the pre-test and 76%, 71%, 65%, 35%, and 61%, respectively, got them correct on the final exam. Two are at the “C” level and three are below but all are significant gains. The poorest end of term question (35% correct) is given a phase of the Moon, tell what time of day it is up highest in the sky. I have two in-class projects involving peer interaction for the phase of the moon/visibility times plus some display on the planetarium dome. This was also poor last semester. It is definitely a higher-level application problem that may require a lab to drive it home.

SLO #2 (scientific method)

On the five questions for this SLO, 39%, 18%, 30%, 17% and 52% got them correct on the pre-test and 91%, 45%, 71%, 67% and 87%, respectively, got them correct on the final exam—about a factor of 2 gain. Three are at the satisfactory or better level. The lowest one is a concept that comes from the reading and is not stressed in lecture. The almost satisfactory one was emphasized more this semester than previous semesters and, therefore, there was almost a factor two gain in how well the students did on the final exam than previous semesters.

SLO #3 (logical reasoning)

Four of the five questions for this SLO #3 are the same as for SLO #1. On the five questions for this SLO, 18%, 10%, 6%, 20%, and 27% got them correct on the pre-test and 59%, 75%, 65%, 35% and 61%, respectively, got them correct on the final exam—large gains from pre-test results but only one at the satisfactory level.
Chemistry 1a SLO work for fall, 2009

Kenward Vaughan

The general education SLO examined this semester is labeled as #1, reading “Demonstrate a knowledge of and recognize the processes that explain natural phenomena.” This SLO is quite broad and lends itself to application across a number of assessments. Within the higher level chemistry 1a class this instructor chose several questions which had been used both in examinations and labs as a means of assessing whether the students had gained some modicum of ability in light of this SLO. These questions and the graded results follow:

- Within the main laboratory practical, the students were required to create an introduction to their report which outlined their MO for the lab (discovery of the ID of a salt). This should have included a theoretical treatment of the basis of their approach to answering the question. The rubric used to grade this is below. 62% of the class scored greater than 4 points in this section, with 44% obtaining 7 or more points.

- Questions used on examinations and the results of each are as follows:
  - A question asking the students to assess the relative energies of systems of charged particles (100% at a B− or higher).
  - A question about finding Ag and Au in the refining of Cu (100% at a C− or higher, about 75% at a B− or higher).
  - A very difficult question requiring application of the theoretical aspects of limiting reagent reactions to laboratory observations (50% got 0 points, 50% scored C− or higher, 25% B− or higher).
  - A question about H-bonding and its consequences seen at the macroscopic level (82% at a C− or better, 53% above a C).
  - A question about gas laws in the real world (freezer door being hard to open a second time) (94% C level, 53% above a C).
  - Difficult question about recognizing endothermic changes (62% C or higher, 31% above a C).

Discussion

Virtually none of these questions would have had more than 10% of the students getting an “acceptable” number of points, were they tested at the beginning of the semester. Overall the students are struggling with these issues despite the results appearing to be acceptable. A gross average of 78% of the class successfully completed these questions, but the results could be higher. Reasons postulated for this are

1. they had no practice on writing such reports before the practical,

2. they are heavily involved in using ALeKS as their homework system, which has vastly different questions than what the instructor uses on examinations—this instructor has seen virtually none of ALeKS requiring conceptual/synthetic analysis or real world ties.

Given these barriers, it is not surprising to see the numbers above. Changes in labs (bringing in experience prior to the practical) and additional handouts to supplement problem exposure seen in ALeKS are planned to try to address these deficiencies.
Specific questions, etc.

Partial rubric used in grading lab reports:

<table>
<thead>
<tr>
<th>Level of achievement</th>
<th>Excellent (9-10 pts.)</th>
<th>Good (7-8 pts.)</th>
<th>Average (5-6 pts.)</th>
<th>Poor (3-4 pts.)</th>
<th>Unacceptable (0-2 pts.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
<td>The topic is introduced, and groundwork is laid as to the direction of the report. This includes a statement of the problem with supporting declarations/limitations. It provides a clear formulation of the proposed solution, with well-stated and referenced reasoning.</td>
<td>A statement of the problem along with a proposed solution. The solution is adequate but perhaps not complete. Supporting reasoning is mostly adequate but lacks completeness.</td>
<td>A statement of the problem is given, but the formulation of a solution is poor or unclear. Supporting reasoning is inadequate. It may not address various aspects of the problem, or it shows little understanding of the problem.</td>
<td>Provides only a simple statement of the problem, perhaps with a attempted statement about its solution which is out of context and/or missing major points.</td>
<td>Missing introduction, or is incorrect in content.</td>
</tr>
</tbody>
</table>

Exam questions:

Which of the following systems has (have) virtually no ability to do work? Presume within each system that everything is identical about the particles except charge.

a) ♦ ♦ ♦

b) ♦ ♦ ♦ ♦

c) ♦ ♦ ♦

d) ♦ ♦ ♦ ♦

e) ♦ ♦ ♦

f) ♦ ♦ ♦

g) none of the above

Of the first four (a-d), which system holds the most potential energy? Of the first four (a-d), which system holds the least potential energy?
In the refining of copper, sizable amounts of silver and gold are recovered. Why is this not surprising??

A student attempting to identify an unknown chloride salt (the cation being the unknown) obtained the following data:

<table>
<thead>
<tr>
<th>experiment →</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>mass of unknown (g)</td>
<td>0.196 g</td>
<td>0.238 g</td>
<td>0.218 g</td>
</tr>
<tr>
<td>volume of 2 M AgNO₃ added</td>
<td>1.5 mL</td>
<td>2.5 mL</td>
<td>2.0 mL</td>
</tr>
<tr>
<td>mass of product AgCl obtained</td>
<td>0.450 g</td>
<td>0.615 g</td>
<td>0.563 g</td>
</tr>
</tbody>
</table>

The lab instructor asked him why he chose those fixed volumes of AgNO₃ instead of being more observant in the lab. The student pulled his earbuds out, thought a few moments, then shrugged.

The somewhat exasperated instructor said “Well, at least some of your data is actually excellent. Good luck figuring out your salt!” He left as the student shrugged again while replacing his earbuds.

What was the instructor referring to when speaking about being observant? What’s the issue concerning the volumes?

Identify the good data. Explain the basis for your decision, including the relevance of any calculations made.

Diethylamine and diethyl ether have virtually identical structures and molar masses. They are shown below. Which substance would you predict to have the lowest Pᵥap? How about the lowest melting point? On what do you base your answers?

Here’s a weird sounding one...

An interesting observation about the use of a freezer has developed from my experiences with these at various companies at which I’ve worked. (Freezers are used to store biological materials and other sensitive things.) Specifically, whenever someone opened a freezer to get some material and the door stayed open for longer than about 15 seconds, they’d have to be sure they got all they needed. This is because, once the door closed, it was virtually impossible to open it again for several minutes!

"Ohhh, Great and Wise Oracle of All Which is Profound!

Which of the following changes is (are) endothermic?

1. vaporization
2. condensation
3. sublimation
4. bond formation
5. bond cleavage
Evaluating Student Learning Outcomes for Chemistry 1A (Fall 2009)

Mike Daniel / 1-13-2010

This document is to evaluate student mastery of Physical Science SLOs in my Chemistry 1A classes.

SLO #1. Demonstrate a knowledge of and recognize the processes that explain natural phenomena

Essay Problem - Test 1

1. Draw a diagram in the left box showing a container with 4 hydrogen and 4 oxygen molecules in the gas phase. A spark in this box causes them to react to produce water with 100% yield. In the right box, show the contents after the reaction. The following shows how these three molecules might look on a molecular scale. Note the oxygen is larger and darker than hydrogen. (4 points)

\[
\begin{array}{c|c|c}
\text{H}_2\text{O} & \text{H}_2 & \text{O}_2 \\
\end{array}
\]

![Diagram of molecules before and after reaction](image)

This problem requires students to understand on a molecular level, how atoms are rearranged in a chemical reaction, and no atoms are created or destroyed in the reaction. The first test was a take home (over a weekend) with students working in groups from 1 to 4 students with the average group being 3 students. The correct answer should show 4 diatomic hydrogen and 4 diatomic oxygen molecules on the left, and 4 water molecules and 2 diatomic oxygen molecules on the right.

- 61/74 students = 86% got a C or better
- 3.5 pts/4 = 88% average grade on problem

I believe grades were high due to students working together and having a lot of time to think about the problem. It also does not require them to express thoughts in writing.
Multiple Choice Problem – Test 2
2. Sodium and potassium have similar chemical and physical properties. This is BEST explained by the fact that both elements

   a. Have the same outer electronic configuration.
   b. Have low relative atomic masses.
   c. Are active metals.
   d. Are in period 1 of the periodic table.

This test was taken individually. Students should understand that common chemical and physical properties arise from elements having the same outer electronic configuration (answer a).

47 correct/63 total = 74% Correct

Many of the wrong answers were answer d. This is incorrect because Na and K belong to the same group (vertical column), not the same period (horizontal row). This is a case of students not knowing the two terms’ definitions precisely.

Essay Problem – Test 3
3. Using the kinetic molecular theory and the definition of pressure, explain on a molecular scale why pressure is proportional to the temperature of the gas when volume and amount of gas is held constant. (6 points)

This problem requires students to use the model of how atoms and molecules of a gas produce pressure. They need to use clear language to explain this.

38/64 = 58.5 % passed this problem with a 4.25/6 or better.

Example 1 – a 5.5/6 = 92% or A answer
The KMT (Kinetic Molecular Theory) states that only temp can charge (sic) the energy of a gas. As temperature rises, velocity of the gas particles rise and create more frequent collisions, thus increasing the pressure of gas in a given system w/(n, v constant). Now using the def’n of pressure. Since Pressure=force/area, temperature increase leads to higher force. So as temp. increases, force is going to increase in an increase of pressure.

Example 2 – a 4.5/6 = 75% or C answer
When temperature is increased there is an increase in velocity amongst the particles. When there is an increase in velocity amongst the particles, the amount of collisions between the particles increase. When there is an increase in the amount of collisions due to an
increase in velocity, there will be an increase in pressure. The kinetic
cellular there (sic) is dependent on temperature to increase the
velocity of the moving particles.

Example 3 – a 4/6 = 67% or D (failing) answer
If P = nRT/V, then a P increases T must also increase to keep it equal if
volume and moles remain constant. As the temperature increases
the molecule’s (sic) speed increases making them hit against the
container with more KE increasing the pressure.

Discussion - This is a difficult problem for students. I believe the use of the
PC gas simulation from OSU helps students to see how the gas
variables are related, but our freshmen do not have a lot of
experience or skill at expressing themselves in writing. I hope to
address this problem by having students write and rewrite answers
to questions. Using the Questions and Answer Forums in Moodle, I
will ask students to answer a question, then let them read other
students answers and then have them rewrite their answer.

Multiple Choice Problem – Final Test

4. The mass of a weighing boat is 0.4385 g. The weighing boat was
placed on a balance, tared and a sample added. The balance read
0.8601 g. The sample was transferred to a beaker. The weighing
boat was then placed on the balance. The balance read 0.042 g.
How much sample was transferred to the beaker?
a. 0.8601 g  
b. 0.8559 g
c. 0.4216 g  
d. 0.4174 g

Discussion - The answer is b. The tared weighing boat has 0.8601 g and
after removing the sample, the mass left is 0.042 g. The difference
is the mass that was transferred to the beaker.
32/64 = 50%. Correct
The percent correct is twice what would be expected if students randomly
guessed. This was the last question (70th) on the grey test and the
next to the last question on the equivalent yellow test. At the end of
a long final test and at the end of a long semester, I think many
students were experiencing test fatigue, and just guessed. The final
weighing of the sample boat showing that not all of the sample was
transferred to the beaker was not done in lab, so this step should
be added to lab. The balances used in this problem had a greater
precision than those used in lab so this leftover mass may not be
as oblivious.
SLO Activity for F2009, S2010 Physical Science Department
Dan Kimball, Chemistry Instructor

SLO to be addressed: Demonstrate knowledge of and recognize the processes that explain natural phenomena.

"I" if the SLO is Introduced
"D" if the SLO is Developed and practiced with feedback
"M" if the SLO is Mastered and Measured

Chemistry 2A: The SLO above is an inherent part of my chemistry course.

In my Chemistry 2A classes I explicitly introduce the above SLO in my syllabus that I provide for my students on my web site (I email them up to 1 month before the class begins to ready and study my syllabus and go over it in detail during the first lecture of the class.

I then proceed to assign online homework, give lecture quizzes at the end of each lecture, conduct laboratory activities including a prelab assignment and a lab report as well as give 2-3 exams and a comprehensive final examination.

80% or more of my students pass the class with a standard bell shaped grade distribution indicating the degree of mastery of the SLO above.

Physical Science 12: The SLO above is an inherent part of my physical science course.

In my Physical Science 12 class I explicitly introduce the above SLO in my syllabus that I provide for my students on my web site (I email them up to 1 month before the class begins to ready and study my syllabus and go over it in detail during the first lecture of the class.

I then proceed to assign online homework, give lecture quizzes at the end of each lecture, conduct laboratory activities, require a lab report as well as give 3 exams and a comprehensive final examination.

85% or more of my students pass the class with a standard bell shaped grade distribution indicating the degree of mastery of the SLO above.
Assessment of SLO’s for Fall Semester 2009, Earth Science Lecture  
Jack Pierce

The Earth Science lecture class was given a pre-assessment test at the beginning of the Fall Semester, 2009. The same pre-assessment test was administered to the same students at the end of the semester. The pre-assessment test is comprised of 25 questions which assess the student's knowledge of the three Physical Science Department SLO’s. Below is the percentage breakdown of correct responses at the beginning of each semester (ABS) and correct responses at the end of the semester (AES) for each question that represents each department SLO.  

SLO #1 Demonstrate knowledge of and recognize the processes that explain natural phenomena.  

<table>
<thead>
<tr>
<th>Question</th>
<th>% Correct ABS</th>
<th>% Correct AES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23%</td>
<td>82%</td>
</tr>
<tr>
<td>2</td>
<td>18%</td>
<td>73%</td>
</tr>
<tr>
<td>3</td>
<td>14%</td>
<td>68%</td>
</tr>
</tbody>
</table>

SLO #2 Apply methodologies of science when approaching a problem.  

<table>
<thead>
<tr>
<th>Question</th>
<th>% Correct ABS</th>
<th>% Correct AES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>21%</td>
<td>67%</td>
</tr>
<tr>
<td>2</td>
<td>18%</td>
<td>65%</td>
</tr>
</tbody>
</table>

SLO #3 Apply quantitative and qualitative reasoning in solving problems or analyzing arguments.  

<table>
<thead>
<tr>
<th>Question</th>
<th>% Correct ABS</th>
<th>% Correct AES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10%</td>
<td>88%</td>
</tr>
<tr>
<td>2</td>
<td>12%</td>
<td>91%</td>
</tr>
</tbody>
</table>

According to the data above, students demonstrated improvement in all three SLO categories. Overall, lecture material and various lecture assignments are helping students master the content that applies to each SLO; however, percentages are low for SLO #2. It is apparent to the instructor that more emphasis should be placed on methodologies of science throughout the lecture series. Both questions in SLO #2 deal with the scientific method concept. To improve SLO #2 percentages, the instructor will incorporate the steps of the scientific method into various lectures throughout the semester. Below are the three department SLO’s and the pre-assessment questions applicable to each SLO. Each pre-assessment question is represented in the data table above.
A. Demonstrate knowledge of and recognize the processes that explain natural phenomena.

1. Which process does **NOT** belong to the water cycle?
   a. condensation  
   b. soil  
   c. run-off  
   d. evaporation

2. The most current theory describing how plates move creating the various plate boundaries is explained by the process of convection. Which example expresses the current convection theory of plate movement?
   a. Homogeneous convection throughout the mantle
   b. Conduction convection within the lithosphere
   c. The “lava – lamp”
   d. Rising and falling air

3. As a balloon rises in the atmosphere, which of the following takes place?
   a. Atmospheric pressure increases as altitude increases.
   b. The inside pressure in the balloon decreases as atmospheric pressure decreases.
   c. The balloon begins to expand because the outside atmospheric pressure becomes less than the inside pressure of the balloon.
   d. The balloon will stay the same size because atmospheric pressure and balloon pressure are in equilibrium.

B. Apply the methodologies of science when approaching a problem.

1. Which of the following concepts is not part of the scientific method?
   a. hypothesis  
   b. theory  
   c. scientific fact  
   d. prediction

2. Which of the following statements regarding the scientific method is false?
   a. A tentative explanation of a body of data is called a hypothesis.
   b. Theories are less likely to be correct than hypotheses.
   c. A hypothesis is strengthened if it successfully predicts the outcomes of new experiments.
   d. If new evidence indicates that a theory is wrong, the theory may be modified or discarded.

C. Apply logical quantitative and qualitative reasoning in solving problems or analyzing arguments.

1. The concept of Uniformitarianism states:
   a. the present always represents what has happened in the past geologic history of earth.
   b. the key to past geologic processes is observing present geologic processes.
   c. that most geologic processes take place over a short period of time.
   d. that all earth processes take place uniformly.

2. The HR-diagram:
   a. classifies stars based on star temperature and star magnitude.
   b. classifies stars based on star brightness and star magnitude.
   c. classifies stars based on star temperature and heat index.
   d. classifies stars based on star power and celebrity status.
Assessment for Geog B1
John Menzies

Instructor’s responsibility

- present information related to natural processes and earth as a system in class
- formulate exam questions related to these topics
- assessments were done on exams 1, 2, 3
- observe and tally the results

Student’s responsibility

- understand the slos
- demonstrate the understanding on exams

Assessment for Geog B1L

Instructor’s responsibility

- teach slo related techniques for problem solving in the lab
- select a specific lab problem to test the students understanding
- the problems were selected from Lab#4 Public Lands survey system, Lab #8 Topographic Maps, and lab #9 Cross-sectional Profile Drawing
- observe and tally the results

Student’s responsibility

- understand the slos
- solve problems related to the slos
- use critical thinking methods to analyze scenarios

Results: Overall it seemed that the results were fairly consistent. In most instances the slos steadily improved from start to finish, while in other cases they stayed fairly constant (correct answers within a few percentage points either way). By using multiple choice questions for the lecture assessments I found that the results had improved. With multiple choice questions, answers are either judged as right or wrong. This new method eliminated the instructor’s objectiveness while grading. I will continue this method in the future. As for the lab, multiple choices questions could not be used, but the questions provided in the lab manual seemed effective enough to make a good assessment. Given the overall good quality of the results, these methods will be used again next semester.
Sample Questions Used and results for each class:

**MW Lecture**

<table>
<thead>
<tr>
<th>#1 Natural Processes</th>
<th>Exam</th>
<th>5. What is cloud-albedo forcing?</th>
<th>52/100</th>
<th>52</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 Earth as a system</td>
<td>#1</td>
<td>23. Why does temp. increase with height in Stratosphere?</td>
<td>61/100</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#2 Natural Processes</td>
<td>Exam</td>
<td>5. What is coriolis force?</td>
<td>86/96</td>
<td>0.895833</td>
</tr>
<tr>
<td>#2 Earth as a system</td>
<td>#2</td>
<td>6. Relationship between air pressure and elevation</td>
<td>62/96</td>
<td>0.645833</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#3 Natural Processes</td>
<td>Exam</td>
<td>11. Type of chemical weathering?</td>
<td>70/91</td>
<td>0.769231</td>
</tr>
<tr>
<td>#3 Earth as a system</td>
<td>#3</td>
<td>6. What is hypsometry?</td>
<td>76/91</td>
<td>0.835165</td>
</tr>
</tbody>
</table>

**M Lecture**

<table>
<thead>
<tr>
<th>#1 Natural Processes</th>
<th>Exam</th>
<th>5. What is cloud-albedo forcing?</th>
<th>28/45</th>
<th>0.622222</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 Earth as a system</td>
<td>#1</td>
<td>23. Why does temp. increase with height in Stratosphere?</td>
<td></td>
<td>0.822222</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#2 Natural Processes</td>
<td>Exam</td>
<td>5. What is coriolis force?</td>
<td>38/43</td>
<td>0.883721</td>
</tr>
<tr>
<td>#2 Earth as a system</td>
<td>#2</td>
<td>6. Relationship between air pressure and elevation</td>
<td>34/43</td>
<td>0.790698</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#3 Natural Processes</td>
<td>Exam</td>
<td>11. Type of chemical weathering?</td>
<td>33/39</td>
<td>0.846154</td>
</tr>
<tr>
<td>#3 Earth as a system</td>
<td>#3</td>
<td>6. What is hypsometry?</td>
<td>30/39</td>
<td>0.769231</td>
</tr>
</tbody>
</table>
### T Lab

<table>
<thead>
<tr>
<th>#1 Natural Processes</th>
<th>Lab 3 - Why more energy at south pole than north pole on solstice</th>
<th>11 out of 14</th>
<th>0.714286</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 Topo Maps Lab 4</td>
<td>What is survey designation of applegate peak?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lab 8 - Crater lake wants to build a hiking trail...</td>
<td>7 out of 9</td>
<td>0.777778</td>
</tr>
<tr>
<td>#2 Topo Maps Lab 4</td>
<td>Lab 8 - How long to walk highway 178</td>
<td>7 out of 9</td>
<td>0.777778</td>
</tr>
<tr>
<td>#3 Natural Processes</td>
<td>How profiles can be used?</td>
<td>11 out of 11</td>
<td>1</td>
</tr>
<tr>
<td>#3 Topo Maps Lab 9</td>
<td>Oil Center Profile</td>
<td>9 out of 11</td>
<td>0.818182</td>
</tr>
</tbody>
</table>

### W Lab

<table>
<thead>
<tr>
<th>#1 Natural Processes</th>
<th>Lab 3 - Why more energy at south pole than north pole on solstice</th>
<th>6 out of 13</th>
<th>0.461538</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 Topo Maps Lab 4</td>
<td>What is survey designation of applegate peak?</td>
<td>11 out of 12</td>
<td>0.916667</td>
</tr>
<tr>
<td></td>
<td>Lab 8 - Crater lake wants to build a hiking trail...</td>
<td>8 out of 9</td>
<td>0.888889</td>
</tr>
<tr>
<td>#2 Topo Maps Lab 4</td>
<td>Lab 8 - How long to walk highway 178</td>
<td>7 out of 9</td>
<td>0.777778</td>
</tr>
<tr>
<td>#3 Natural Processes</td>
<td>How profiles can be used?</td>
<td>9 out of 9</td>
<td>1</td>
</tr>
<tr>
<td>#3 Topo Maps Lab 9</td>
<td>Oil Center Profile</td>
<td>9 out of 9</td>
<td>1</td>
</tr>
</tbody>
</table>
Assessment Part 1: The pre & post semester assessment quiz.

I only compared results for the students who completed both quizzes, one by one picking out all the pre-semester assessments belonging to students who did not complete the post-semester assessment. The quizzes involved 3 parts, one for each of our SLOs. The pre-semester assessment was given on the first day of class during class time and the post-semester assessment was given alongside the final exam.

SLO #1 (understanding natural processes)
Pre-semester 0% achieved greater than a C on this section, 4% achieved a C, and the remainder failed horribly. This result was expected due to all the processes questions being geological in nature and probably the students had never heard of these concepts before.
Post-semester 25% achieved greater than a C and 27% achieved a C, collectively a sad 52% of the class passing this section acceptably. I believe that part of this lack of success is due to my having worded some questions vaguely; for example when I asked about the importance of water to geology I was looking for “erosion” not “necessary for life”… and gave zero points for that answer. If I had made these questions multiple choice, then it’s possible they might have selected “erosion”, but I can’t say that for sure.

SLO #2 (scientific method)
Pre-semester 10% achieved a C or greater on this section.
Post-semester 52% achieved greater than a C and 21% achieved a C, this gives me a grand total of 73% (a C!!!) who actually learned the scientific method. I attribute this largely to my redundant repetition of the concept in every possible way almost daily throughout the semester.

SLO #3 (logical reasoning)
For this SLO I provided some basic logical reasoning questions that I expected most of the students to be able to complete with a little bit of thinking (duh), but that all students who completed the lab should know inside and out by the end of the semester.
Pre-semester 48% achieved greater than a C and 27% achieved a C on this section.
Post-semester 66% achieved greater than a C and 30% achieved a C, of the 4% who failed this section 2 students did not complete it at all, possibly because it was on the back of the page and they did not flip it over, which is part of the concept “logical reasoning” in itself, so they probably deserved to fail.
Assessment Part 2: “Concept” questions on exams.

For this part of the evaluation I had 3 questions (1 on each of 3 exams) that assembled more than 1 concepts together in order to assess logical reasoning and a natural process and/or the scientific method. While I believe that this can be a qualitative assessment of all three SLOs together, quantitatively it can really only be used to examine SLO #3.

**Question 1 (scientific method, logical reasoning, plate tectonics)**

Did not answer: 8%
Failed: 42%
Earned a C: 15%
Earned greater than a C: 35%

I think it’s important to note that for this question, more than 80% of the students who failed it actually earned a D and not an F. It’s still a fail, but it’s not as if they knew none of the material at all.

**Question 2 (logical reasoning, rock cycle)**

Did not answer: 4%
Failed: 37%
Earned a C: 24%
Earned greater than a C: 35%

SIGH

**Question 3 (logical reasoning, deserts, axial tilt)**

Did not answer: 6%
Failed: 69%
Earned a C: 4%
Earned greater than a C: 18%

Well, this exam had the lowest overall average. Maybe it was just that time of year… I gave this right before Thanksgiving. This was also another example of where the vast majority of the fails were Ds. It seemed as though the students for this question knew only about half of what the were supposed to, but there was NO consistency on WHICH half the material they knew – it was clear across the board that everyone remembered some information, but no one remembered the same bits and pieces. WEIRD.
A 10-question quiz (attached) on the basic nature of Science was administered to General Physical Science (Physical Science B12) students on the first day of instruction, prior to any instructional activity. The same quiz was administered two weeks later, after full lecture instruction on the subject matter and one lab with two experiments utilizing the scientific method.

The questions fell into three groups by subject matter.

Questions 2, 3, 4, 5 and 7 dealt with the nature of Scientific thinking and the Scientific method.

Questions 6 and 8 dealt with the systematic organization and classification of Science.

Questions 1, 9 and 10 dealt with the way accepted scientific concepts change over time.

<table>
<thead>
<tr>
<th>Question</th>
<th>% Correct Before Instr</th>
<th>% Correct After Instr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>53</td>
<td>90</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>78</td>
</tr>
<tr>
<td>3</td>
<td>42</td>
<td>53</td>
</tr>
<tr>
<td>4</td>
<td>51</td>
<td>93</td>
</tr>
<tr>
<td>5</td>
<td>85</td>
<td>95</td>
</tr>
<tr>
<td>6</td>
<td>47</td>
<td>78</td>
</tr>
<tr>
<td>7</td>
<td>74</td>
<td>98</td>
</tr>
<tr>
<td>8</td>
<td>45</td>
<td>85</td>
</tr>
<tr>
<td>9</td>
<td>34</td>
<td>53</td>
</tr>
<tr>
<td>10</td>
<td>65</td>
<td>46</td>
</tr>
</tbody>
</table>

The percentage of correct responses to all questions except number 10, improved dramatically (by 10% or more) with instruction.

The percentage of correct responses to question 10 declined from 65% to 46% with instruction.

CONCLUSION: Instruction successfully improves comprehension and understanding of basic concepts of science.

IMPROVEMENT OF INSTRUCTION: Instruction on the Scientific Method (questions 3 and 5 improved the least (only 10 or 11%) and should be emphasized with greater lecture detail and clarity. Laboratory exercises applying these principles are already being applied, but it usually takes several weeks of such exercises for these ideas to sink in.

Question 10 dealt with the recognition of the name of a scientist (Isaac Newton) responsible for significant advances in Scientific thought. The clarity of lecture presentation of scientists and their ideas, and the evolution of scientific thought, can be improved with the use of comparative tables.
Physical Science 12
Quiz 1

DO NOT WRITE OR MARK ON THIS QUESTION SHEET.
Mark the SINGLE, BEST CHOICE for an answer to each question on your SCAN-TRON form.

Introduction to Science and Physical Science
1. During a paradigm shift, what sort of scientist is most apt to lead the scientific revolution?
   A. older, more established scientists  B. younger, more open-minded scientists
   C. scientists from other disciplines  D. prize-winning, famous scientists
   E. unrespected, marginal scientists whom everybody thinks are real nerds

2. Which of the following philosophical approaches is used by Science?
   A. teleology  B. extra sensory perception  C. subjectivity
   D. intuition  E. causalism

3. Which characteristic of the Scientific Method distinguishes it from other forms of scholarly research?
   A. logical reasoning  B. review by other scholars in the field
   C. hypotheses  D. observational or experimental test  E. observations

4. Which of the following is a scientific definition of a theory?
   A. Theories represent guesses that have not yet been compared with observational data.
   B. A theory is a summary of a particular group of experiments
   C. Theories are thoroughly tested and accepted explanations of Nature, but they must be constantly reviewed to see whether they are in accord with new experimental observations.
   D. A theory is a law of nature, and is not subject to revision.
   E. A theory is a sacrosanct holy truth and must not ever be violated or questioned.

5. With his experiments, a scientist is testing
   A. the Truth  B. the observation  C. the conclusion
   D. the instruments  E. the hypothesis

6. Which branch of Physical Science deals with the composition, properties and changes in matter?
   A. Chemistry  B. Physics  C. Geology  D. Astronomy

7. Why should the public be willing to pay for science?
   A. yesterday’s pure science is often today’s applied science and tomorrow’s technology
   B. national prestige can be enhanced by lots of Nobel Prize winners
   C. scientists can invent more powerful weapons to keep our nation strong
   D. scientists can discover more ideas to teach in science classes in school, thus giving science teachers job security

8. Physics is the branch of physical science that studies
   A. matter and its changes  B. the stars, planets and universe beyond the Earth
   C. forces of nature and their interaction with matter  D. changes in the atmosphere
Development of Scientific Models of the Solar System
9. Which of the following represent the most current scientific viewpoint for explaining the apparent motions (as seen from the Earth) of the Sun, Moon and Planets?
   A. The force of Newton’s Law of Gravitation pulling between the Sun, Earth, Moon and Planets, keeping them in elliptical orbits as described by Kepler, in accordance with Newton’s Laws of Motion, but modified with Einstein’s Theory of Relativity for objects close to the sun, which warps space-time
   B. Earth-centered Ptolemaic system, with Sun, Moon and Planets moving in circular cycles and epicycles
   C. Sun-centered Copernican system, with a rotating Earth, and Earth and Planets moving in circular orbits, and the Moon in a circular orbit about the Earth
   D. Sun-centered system of Kepler, with a rotating Earth, and Earth and Planets moving in elliptical orbits, and the Moon in an elliptical orbit about the Earth
   E. The force of Newton’s Law of Gravitation pulling between the Sun, Earth, Moon and Planets, keeping them in elliptical orbits as described by Kepler, in accordance with Newton’s Laws of Motion

10. Which scientist derived the Theory of Universal Gravitation and the Classical Laws of Motion, to describe the motion of objects on Earth, as well as the motion of the planets?
   A. Ptolemy   B. Copernicus   C. Kepler   D. Newton
   E. Einstein
Department SLO # 1 for Fall 2009 semester was that “demonstrate a knowledge of and recognize the processes that explain natural phenomena.”

Nine multiple choice questions were given to my Physics B2A students to evaluate the scientific methods, logical reasoning and knowledge of process. Two evaluations were made to monitor improvement, one at the beginning of the semester and another at near the end of the semester.

The result of the first evaluation administered in September, 2009 was as follow:

The number of the students evaluated: 61
Class average: 56 %
Above 85 % correct answer: 11 %.

The first assessment result was very poor, and it seems that many of the students have not practiced the scientific methods and logical reasoning in their previous courses.

The same questions were given to the same class near the end of the semester, and the result of the second assessment was as follow.

The number of the students evaluated : 37
Class average: 74 %
Above 85 % correct answer: 29 %.

After performing the scientific methods and logical reasoning almost every session in lecture and lab of the course, the students have made significant improvement in the department SLO # 1.
SLO #1: Demonstrate a knowledge of and recognize the processes that explain natural phenomena.

Assessment method: Seven problems were selected from the Physics B4B course final exam to assess the degree to which students showed that they were able to recognize and demonstrate a knowledge of processes that explain natural phenomena (in the context of a course in Maxwellian physics). The problems were synthesis problems in which a key (implicit) natural process was necessary for the student to recognize and utilize in order to accomplish a (explicit) problem goal. After the usual grading of these final exams for the 49 students in the course, each problem was reevaluated and assigned a numerical index of 0, 1, or 2, which reflected the students’ demonstration by documented work their success in recognizing and utilizing the knowledge of these processes in achieving the problem’s goal (which was usually arriving at a numerical answer for some physical quantity asked for). The key for these numerical indices is shown in the table below. The analysis done shows the mean value of this index for each of the 7 problems, averaged over the 49 students. Also computed for each problem is the percentage of all students receiving either a 1 or 2 on the problem, indicating the percentage of students in the course that “recognized and applied the knowledge of the physical process as judged from their documented work shown”.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Explicit Problem Goal</th>
<th>Implicit Natural Process</th>
<th>Number of Students Assessed</th>
<th>Number of Students Assessed</th>
<th>Number of Students Assessed</th>
<th>Mean Rating Index for All Students</th>
<th>Percentage of Students with a Rating of Either 1 or 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>Determine the fractional increase of surface area of an object in a thermal mixing problem</td>
<td>spontaneous heat transfer and conservation of heat energy</td>
<td>2</td>
<td>1</td>
<td>46</td>
<td>1.90</td>
<td>95.9</td>
</tr>
<tr>
<td>#2</td>
<td>Determine the efficiency of a heat engine employing a specified cyclic process</td>
<td>conversion of energies between work, heat, and internal energy</td>
<td>8</td>
<td>13</td>
<td>28</td>
<td>1.41</td>
<td>83.7</td>
</tr>
<tr>
<td>#3</td>
<td>Determine the electric force on one point charge given a discrete charge configuration</td>
<td>nature and logistics of electric forces as embodied by Coulomb’s Law</td>
<td>0</td>
<td>12</td>
<td>37</td>
<td>1.76</td>
<td>100.0</td>
</tr>
<tr>
<td>#4</td>
<td>Determine the power dissipated by a selected resistor in a multiloop DC resistive circuit</td>
<td>conservation of energy and continuity of electric source</td>
<td>9</td>
<td>7</td>
<td>33</td>
<td>1.49</td>
<td>81.6</td>
</tr>
<tr>
<td>#5</td>
<td>Determine the voltage drop across a capacitor in a network after a switching process</td>
<td>logistics of how charge distributes or redistributes itself on a conductor</td>
<td>13</td>
<td>26</td>
<td>10</td>
<td>0.94</td>
<td>73.5</td>
</tr>
<tr>
<td>#6</td>
<td>Determine magnitude and direction of the magnetic field produced by a combination of currents</td>
<td>structure of the magnetic field produced by a current-carrying wire</td>
<td>2</td>
<td>37</td>
<td>10</td>
<td>1.16</td>
<td>95.9</td>
</tr>
<tr>
<td>#7</td>
<td>Determine the emf around a circuit loop given changing conditions in the loop and environment</td>
<td>the role of changing magnetic flux in the induction of an emf</td>
<td>23</td>
<td>10</td>
<td>16</td>
<td>0.86</td>
<td>53.1</td>
</tr>
</tbody>
</table>

This assessment was completed on 12-29-2009 by course instructor R. M. Darke.