Course Portfolio Duncan Sibley, Fall Semester 2008,
Course: ISP 203A Understanding the Earth: Global Change

(1) Teaching Experience and Responsibilities

Term - Fall
Year – 2008 and one section per year for the past decade.
Course – ISP203A
Course Title – Understanding the Earth: Global Change
Co-instructors - None
#Sections = 1 section
#Students = 200 students
#Grad.Assistants = 0 GA
#Undergrad Assistants = 1 UGA
Course Syllabus – the syllabus for Fall 2008 is attached as Appendix A.

(2) Teaching Goals
(a) General goals of ISP203A. There are six general goals for student learning
outcomes in Integrative Studies, three of which are particularly relevant to the natural
sciences.
1. Become more familiar with the ways of knowing in the arts and humanities, the
   biological and physical sciences, and the social sciences.
2. Develop a range of intellectual abilities, including critical thinking, logical argument,
   appropriate uses of evidence and interpretation of varied kinds of information
   (quantitative, qualitative, text, image).
3. Learn more about the role of scientific method in developing a more objective
   understanding of the natural and social worlds.
(b) Specific goals of ISP203A  At the beginning of spring semester 2008, I asked the
students to help re-write the goals. I did this mostly to attempt to generate more
ownership of the course by the students. The three goals we all agreed on are:
1. Use theories and models as unifying principles that help us understand natural phenomena and
   make predictions.
2. Illustrate the interdependence between developments in science and social and ethical issues.
3. Evaluate the credibility use and misuse of scientific information in scientific developments and
   public policy issues.
As discussed below, I was able to design instruction to address all three goals in a class of 100
students (SS08) but cannot in a class of 180 students (FS 09). I am confident that goal #1 is being
addressed and met with this larger class.
**Teaching Methods and Strategies**

This is a large enrollment lecture course that meets for two 80-minute periods per week. Approximately 70% of the time is spent in lecture and the rest is spent working through “clicker” questions or inclass written exercises. The clicker questions typically focus on readings due the day of class. The example question on the relationship between temperature and the amount of gas that may dissolve in a solution (appendix B1) follows a reading assignment on dissolution and precipitation. Notice that the question includes a representation of a gas dissolved in a solution. This drawing is the focus of the subsequent discussion of why the correct answer is B. This example is from the middle of the semester. Later in the semester, students will use this concept to understand degassing of magmas and, toward the end of the semester, dissolution and degassing of CO₂ from the oceans. This is an extremely important concept in the study of global change because gas exchange between the oceans and atmosphere is the dominant process that regulates short-term (100’s of years) climate change.

Written inclass exercises are more challenging and informative than clicker questions. These are practice examples of what students will have to do on the tests. The first example is a box and arrow diagram of the water cycle (Appendix B 2). I developed these as an instructional and assessment tool because they guide the students toward detailed, complete answers. Students work on the water cycle at the beginning of the semester because they are familiar with most of the important processes. Later in the semester they use box and arrow diagrams to trace the major elements in the earth’s crust through the rocks cycle and, at the end of the semester, carbon through the carbon cycle. The second example (Appendix B, 3) challenges students to develop and use analogies. I have students practice drawing and making inferences from analogies for two reasons. First, some leading cognitive scientists argue that drawing analogies is the most common way people learn. Second, the models used by geoscientists are analogies. Therefore, I give students lots of opportunities to draw analogies. For example;

1) Draw an analogy between dissolution (target) and some analog you know well.
2) Based on your knowledge of the analog and assumed similarities between dissolution and the analog, make a prediction about dissolution.
3) Describe a way you might test your prediction.

Notice that this exercise builds on the clicker exercise shown in appendix B1.
Homework, presented on LON CAPA, is an important part of this class. Approximately 60% of the homework is designed to simply re-enforce the factual knowledge needed for the class. This allows us to spend more time in class with clicker questions and written exercises. The other 40% of the homework exercises involves quantitative and qualitative problem solving. For example, students learn the concept of residence time as a means of assessing how rapidly reservoirs may change in size almost completely via readings and LON CAPA homework (appendix C). The concept is used in lecture but the basics are introduced through LON CAPA homework.

I wrote a textbook because no existing textbook provides the molecular level to systems level approach to movement and change of earth materials that I have used to help students understand global change. The text is posted on line for students’ free access.

(4) Assessment of Student Learning

Assessment of student learning has been focused on goal #1, use theories and models as unifying principles that help us understand natural phenomena and make predictions and goal #3, evaluate the credibility use and misuse of scientific information in scientific developments and public policy issues.

Analysis of two exam questions from SS2008 (see Appenix D for the exam) provide a means of assessing student learning.

Responses to the following questions provides a basis for evaluating students ability to use models to make predictions about natural phenomena.

1.a Draw an analogy between the water cycle and the carbon cycle.
1.b Based on some aspect of the analog, make a prediction about the target.
1.c State one way you could test your prediction.

A correct response would be.

Analogy: Evaporation is an analog for CO₂ degassing.
Prediction: Degassing will increase with temperature.
Test: Measure the amount of CO₂ degassed from beakers of water heated to different temperatures.

A rubric, summarized in Table 1, was used to assess students’ responses in Spring semester 2008. (Table 2).
Table 1 A rubric for scoring students’ analogies.

<table>
<thead>
<tr>
<th>QUESTION COMPONENTS</th>
<th>RATIONALE and SCORING RUBRIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Write an analogy for __________. You may include a drawing or diagram in your answer.</td>
<td>Each analog will be categorized as relational, descriptive, other. Correct relational or descriptive analogs will be scored 1. The other category includes non-analogs.</td>
</tr>
<tr>
<td>2. Make a prediction based on the analog.</td>
<td>We score this as 0 - no prediction or prediction not related to the analog or 1 - prediction related to analog.</td>
</tr>
<tr>
<td>3. Test your prediction.</td>
<td>SCORING RUBRIC: We score this as 0 - no test or 1 – a reasonable test.</td>
</tr>
</tbody>
</table>

The scores, based on this rubric are shown in table 2. The first four rows are examples of how a single student’s responses may be scored. The first four columns show the types of analogs. For example, the first student (top row) wrote a relational analogy but failed to make a reasonable prediction or test of the prediction. The second student did not draw an analogical statement but did make a prediction that is reasonable based on the statement. The final column, argument, is simply the sum of the columns. The third row student drew a relational analogy, made a reasonable prediction and stated a reasonable way to test the prediction. With these three components, the student has made a valid argument as designated by the 3 in the last column. The last row is the summary of results for all students. Seventy-two percent drew reasonable relational analogies. Eighty-four percent drew reasonable predictions based statements of analogy. Note that this prediction could be logically correct even if the analog was not reasonable. Seventy-six percent of the students were able to state a way to test their predictions.

<table>
<thead>
<tr>
<th></th>
<th>Relational</th>
<th>Descriptive</th>
<th>Other</th>
<th>Prediction</th>
<th>Test</th>
<th>Argument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water-carbon</td>
<td>1</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>cycle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>9%</td>
<td>16%</td>
<td>84%</td>
<td>76%</td>
<td>No.3s=53%</td>
</tr>
</tbody>
</table>

Table 2. Tabulation of students’ scores on the water-carbon cycle analog. 72% of the students drew correct relational analogs. Eighty-four percent of the students were able to formulate a prediction and 76% were able to state a test for the prediction. Fifty-three percent succeeded in writing a relational analog, making a reasonable prediction and stating a way to test that prediction.
The fact that 81% of the students were able to correctly draw relational or descriptive analogies indicates they understand some of the basic concepts in both cycles. This basic understanding is described further in the assessment of box and arrow diagrams responses. I’m disappointed that only 53% of the students correctly used relational analogs to make testable predictions. However, I have no standard against which to measure students’ ability to reason. A similar question will be given on subsequent final exams to see if the number of 3s increases.

A second type of question which was on the fourth test and which provides a good assessment of goal 1 is the Grandma Rockford problem. This requires students to apply basic models of how matter moves and changes through the carbon cycle.

4. Grandma Rockford spent most of her life living on a volcano in Washington State. When her husband died, she marked his grave with her favorite stone, marble. Some day, she thought, when I die, part of this volcano and I may be joined together in a beautiful piece of marble. What movements and changes occur that could cause carbon atoms from Grandma Rockford’s remains and calcium atoms from the volcano to become joined in single piece of marble. Answer this question using a box and arrow diagram.

Over 80% of the students correctly answered this question. I interpret this result, in combination with the results from the preceding analogical reasoning question, to indicate students can reason appropriately in context (grandma Rockford question) but combining analogs with predictions and tests is more challenging for them.

(5) Evaluation of Teaching

(a) Peer evaluation.
Professor Fujita visited my class in November 2008, and later discussed his observations with me. He has written a letter that evaluates my teaching, including the goals and methods. The letter is included as Appendix E.

(b) Student ratings. The course ISP203A was evaluated by the students using the standard course evaluation form provided by the Center for Integrative Studies-General Science.

Student ratings (via SIRS) for my ISP course indicate above average levels of
satisfaction amongst my students (Table 3). The main areas I would like to improve are organization and course rating. The organization rating suffers somewhat because some students object to the lack of a textbook. I have written most of the text and posted it on line but they also have to learn content from websites like Wikipedia and the US Geological Survey. Several students have told me they would prefer to have all the information in one textbook. They also doubt the veracity of Wikipedia, even though I assure them that the material I choose is sound. Some Integrative Studies General Science faculty’s courses are consistently rated in the range of 1.5. I think I can improve the rating of this course by decreasing some of the science content and increasing the focus on some of the culture and social aspects of climate change.

<table>
<thead>
<tr>
<th>ISP 203A: Global Change section</th>
<th>Concern for Learning</th>
<th>Intellectual Challenge</th>
<th>Well Organized</th>
<th>Course Rating</th>
<th>Instructor Rating</th>
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</thead>
<tbody>
<tr>
<td>Spring 2008</td>
<td>1.58</td>
<td>1.95</td>
<td>2.07</td>
<td>2.09</td>
<td>1.72</td>
</tr>
<tr>
<td>1997-2006 (n=62) ISP 203 Average*</td>
<td>2.20</td>
<td>2.15</td>
<td>2.00</td>
<td>2.26</td>
<td>2.03</td>
</tr>
</tbody>
</table>

Table 3. Ratings for Selected SIRS Questions
*Note: Data for academic year 2004-2005 were not available. SIRS Scores: 1.0: EXCELLENT; 2.0: ABOVE AVERAGE; 3.0: AVERAGE; 4.0: BELOW AVERAGE; 5.0: POOR.

(6) Challenges and Recommendations

The greatest challenge I find is designing assignments in which students can practice addressing questions that involve the intersections of science with ethics, policy and culture. I had only 100 students in the class one semester (it was scheduled MWF at 8AM) and was able to assign a group project on the scientific, political and social dimensions of climate change. Because I was able to read and commented on rough drafts, I think the project was successful. However, I cannot accomplish this with the more typical enrollments of 200-250.

My recommendation is to change the structure of ISP/ISB. If lab were dropped and lecture courses expanded to 4 credits, GTAs could be available to help grade written assignments that would better address the Integrative Studies Goals.

(7) Scholarship of Teaching

I have published two articles about student learning in ISP203A


In addition, I have developed an extensive library of LON-CAPA problems at the level appropriate for first-year students. These problems are available in the LON-CAPA author space, and are published for anyone else to use within the LON-CAPA system.

**Appendices**

(A) Syllabus for PHY 101

(B) Examples of in class exercises and clicker questions

(C) LON CAPA homework

(D) Final Exam

(E) Peer Evaluation
APPENDIX A: SYLLABUS

ISP203A: sec. 3 Understanding the Earth: Global Change
The honest debate is Not about whether or not the world is changing in ways that will seriously effect our lives.
The question is what we choose to try to understand and what we choose to do with that understanding.

Class hours:  T Th 1:00-2:20
Rm 128 Nat. Sci. Bldg
Instructor: Dr. Duncan Sibley
Office: 114 Natural Science
Phone: 353-8307
Email: sibley@msu.edu
Office Hours: M 8:00-9:00
Fr 9:00-10:00
Other times by appointment

Course Goals
1. Use theories and models as unifying principles that help us understand natural phenomena and make predictions.
2. Illustrate the interdependence between developments in science and social and ethical issues.
3. Evaluate the credibility use and misuse of scientific information in scientific developments and public policy issues

TEXT: There is no text for this class. Readings will be posted online on LONCAPA.

CLICKERS: iclickers are strongly suggested but not required because the points you will earn are bonus points. Other brands will not work. If you have an iclicker from a pervious class, you can use it. To get the bonus credit for the iclicker questions, you must register your iclicker. Please follow these steps.
1. Use the iclicker in our class. You can not register the iclicker before you use it in class.
2. go to www.iclicker.com/registration
3. Complete the fields with your last name and student ID (i.e., Jones, jones183) and remote ID (the numbers and in some cases letter on the back of your clicker.)

Lecture notes are available on LON CAPA. To find the notes log on to LON CAPA then go to Navigate Documents. Open the folder titled Lecture Notes then double click on the lecturer you want and save it to your computer. You may have trouble reading and/or printing the notes directly from LON CAPA.
If you don’t have Powerpoint and Microsoft Word on your computer you can use a computer in a university computer lab or download a Powerpoint & Word viewer at:


Laboratory: The laboratory for this course is OPTIONAL but recommended.
<table>
<thead>
<tr>
<th>Lecture Topic</th>
<th>Date</th>
<th>Read before the date</th>
<th>Topic</th>
<th>Read before the date</th>
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<tbody>
<tr>
<td>Course Introduction</td>
<td>August 26</td>
<td></td>
<td>Rock cycle</td>
<td>Oct 16</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Read Chapt. 4 Rock cycle (sedimentary rocks) On LON CAPA</td>
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<tr>
<td>Earth Systems</td>
<td>August 28</td>
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<td>Rock cycle</td>
<td>Oct 21</td>
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<td>Lon CAPA Homework Due Sedimentary Rock Cycle</td>
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<td>Water cycle</td>
<td>Sept 2</td>
<td>Water cycle webpage</td>
<td>Rock cycle</td>
<td>Oct 23</td>
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<tr>
<td></td>
<td></td>
<td><a href="http://ga.water.usgs.gov">http://ga.water.usgs.gov</a> /edu/watercyclesummary .html</td>
<td></td>
<td>Chapt. 5 Rock Cycle (Igneous &amp; metamorphic rocks) Rock Cycle LON CAPA Homework Due</td>
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<tr>
<td>Water cycle</td>
<td>Sept 4</td>
<td>Chapter 1 Water cycle</td>
<td>Rock cycle</td>
<td>Oct 28</td>
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<td></td>
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<td>On LON CAPA</td>
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<td>Rock Cycle exercise due</td>
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<tr>
<td>Water and energy</td>
<td>Sept 9</td>
<td>Chapter 2 Energy and the Water cycle</td>
<td>test 3</td>
<td>Oct 30</td>
</tr>
<tr>
<td>Water and climate change</td>
<td>Sept 11</td>
<td>Chapter 3 Solar energy and water Reading: Runoff &amp; Climate Change</td>
<td>Climate change</td>
<td>Nov 4</td>
</tr>
<tr>
<td>Review for test 1</td>
<td>Sept 16</td>
<td>Hydrologic cycle exercise On LON CAPA due</td>
<td>Climate change</td>
<td>Nov 6</td>
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<tr>
<td>test 1</td>
<td>Sept 18</td>
<td>Read about minerals in wikipedia</td>
<td>Climate change</td>
<td>Nov. 11</td>
</tr>
<tr>
<td>Plate tectonics</td>
<td>Sept. 23</td>
<td>Read about igneous, metamorphic and sedimentary rocks on Wikipedia LON CAPA HW on minerals</td>
<td>Climate change</td>
<td>Nov. 13</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td>Read Climate stabilization (from Nature, Jan 2008) What is the role of positive and negative feedback in climate stabilization? Ethics of climate change</td>
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<tr>
<td>Plate tectonics</td>
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<td>LON CAPA HW on Rocks</td>
<td>Climate change</td>
<td>Nov. 18</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>carbon cycle ex Read: Electricity without Carbon – from Nature</td>
</tr>
<tr>
<td>Plate tectonics</td>
<td>Sept 30</td>
<td><a href="http://pubs.usgs.gov/gip/dynamic/dynamic.html">http://pubs.usgs.gov/gip/dynamic/dynamic.html</a></td>
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<td>Nov.20</td>
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<td>review for final</td>
<td>Dec. 2</td>
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<tr>
<td>Test 2</td>
<td>Oct 9</td>
<td>review for final</td>
<td>Dec 4</td>
<td></td>
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<td>---------</td>
<td>-------</td>
<td>------------------</td>
<td>-------</td>
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<tr>
<td>Rock cycle</td>
<td>Oct 14</td>
<td>Read about the rock cycle on Wikipedia</td>
<td>Dec 8 12:45-2:45 Rm 128 Nat. Sci.</td>
<td></td>
</tr>
</tbody>
</table>

**Laboratory:** The laboratory for this course is OPTIONAL but recommended.

**Online Homework:** There will be online throughout the semester. The due dates expire at 10 PM of the dates are listed above and on the LON-CAPA web server. Once the due date for an assignment has passed, no credit will be given. Homework is made available one or two weeks before the assignment is due. I do not make all the homework available at once because I want the homework, reading and lectures to be roughly synchronized.

To access the homework go to http://msu.lon-capa.org/adm/login/

Enter your pilot ID and password (when you enter your pilot ID- enter just the user name, not your whole e-mail address. For example, I enter sibley, NOT sibley@msu.edu. Please note that the system is case sensitive; so make sure to use all lower case letters.) to see your list of potential user roles. From that list choose ISP203(DS). Be careful not to choose a different ISP203 course. After you choose the course, choose the Navigate button. You’ll find a page that lists homework due dates and the first 3 chapters of question. Click on the homework folder to begin the first set. The boxes with a “?” indicate a homework problem. Other boxes, such as residence time description in homework chapter 1, are explanations that you should read before attempting to complete the homework.

You will receive 1 point for each homework question if you get it correct within three attempts. There are also some short answer questions that ask you to draw analogies. You will receive 1 point for completing these questions.

Computer labs are available all across campus including in most dormitories. Many homework questions contain images, thus you may have long download times unless you have a fast modem or a direct Internet connection. Do not wait until the last day! Some times the system gets overwhelmed with last-minute attempts to do homework. It is your responsibility to do the homework in a timely manner.

Work together! Some of the homework questions are challenging. If you work with another student you have a much better chance of mastering the work. If two of you work together you essentially get 5 tries to get a problem correct. The problems you’ll each see will be a little different, still there is a great advantage to working together.
Evaluation:

LON CAPA homework  5% of total grade - Curved such that 85% on homework =100%.

Quizzes & inclass exercises  15 % of total grade- These will be given frequently. Some quizzes will be announced. Some will not be announced. No makeups. Only 80% of the total points will be need to earn 100% of the credit.

Clicker questions  Clicker questions will be given in class most periods. These are extra credit. You will receive a 3% bonus if you get 80% of these correct. If you course grade is 83% (3.0) then the additional clicker points (3%) would make that 87% (3.5).

Tests- 20 % each - There will be 4 tests. The average score on each test may be curved up such that the lowest score in the upper 10% of the class will equal 90% or above. For example, if the lowest score in the upper 10% were 86%, then everyone would receive an additional 4 points. Test will never be curve down. The lowest of these 4 scores will be dropped.

Final Exam- 20 % The final will be comprehensive.

YOU MAY BRING ONE SHEET OF 81/2 X11 PAPER WITH ANY NOTES, DRAWINGS, ETC. YOU WISH TO EACH TEST. YOU MAY WRITE ON ONE SIDE OF THE SHEET ONLY. PROCTORS WILL CHECK SHEETS DURING THE TEST AND IMMEDIATELY COLLECT ANY THAT HAVE INFORMATION ON BOTH SIDES OF THE SHEET. YOU MAY WRITE OR PRINT THE TEXT AS SMALL AS YOU LIKE BUT YOU MAY NOT BRING A MAGNIFYING GLASS TO READ IT. THIS SHEET MUST BE SIGNED AND TURNED IN WITH YOUR TEST. I SUGGEST YOU WORK WITH A STUDY PARTNER TO HELP DECIDE WHAT YOU WANT TO PUT ON THE SHEET. I do this because most students learn a lot when they create the sheets.

Calculating your grade:  Online homework % (.05) + quizzes % & inclass exercises (.15) + average of 3 highest tests (.60) + final (.20) = grade. For example, if you earn 100% of the on line homework points, 70% quiz points (because you only need 80% to get a perfect score 70/ 80=.88) , and your three tests plus final exam average 83%, and your final exam grade is 90 %:

100(.05) + 88 (.15) + 83 (.60) + 90(.20) = 86 or 3.5

Remember – the clicker scores will be a bonus added to your total.

Grading Scale:  4.0 (90 –100%), 3.5 (85-89), 3.0 (80-84), 2.5 (75-79), 2.0 (70-74), 1.5 (65-69), 1.0 (60-64), 0.0 (0-59)

Tests:  The tests and final will be a combination of 25 objective questions worth 1 point each and approximately 3-5 short response questions worth 10 to 25 points each. Twenty-five percent of each test will be drawn from the online homework objective questions. The other 75% will be from the in class exercises and other home homework exercises. The questions on the tests may use different numbers in problems or slightly different situations, but if you master the homework and in class exercises, you will be able to earn a 4.0 on the tests.
**Classroom Policies**

1) Attendance: Attendance is not required.

2) Respect for others: Due to the large size of this class, students need to respect the learning environment of others. Talking in class, coming to class late and leaving class early are some of the behaviors that disturb others. Any student who disturbs the class may have their final grade lowered. Students will be given two warning before their grade is lowered.

   Please understand why we have these rules. I read the student comments on the back of SIRS forms for all ISP/ISB classes. Question 2 on the form is “What hindered (got in the way) of your learning?” “People talking in class” is one of the most common responses.

3) Academic honesty must be observed in all activities. For more on students’ rights and responsibilities check with the ombudsman: [http://www.msu.edu/unit/ombud/](http://www.msu.edu/unit/ombud/)

   **Academic Honesty:** Article 2.3.2 of the Academic Freedom Report states that the student shares with the faculty the responsibility for maintaining the integrity of scholarship, grades, and professional standards. In addition, the Center for Integrative Studies adheres to the policies on academic honesty specified in General Student Regulation 1.0, *Protection of Scholarship and Grades*; the all-University policy on *Integrity of Scholarship and Grades*; and Ordinance 17.00, Examinations. (See *Spartan Life: Student Handbook and Resource Guide* and/or the MSU Web site [www.msu.edu](http://www.msu.edu).)

4) Makeup exams will have essay and short answer questions.

Note For more information about Integrative Studies General Science go to our web site at: [http://www.ns.msu.edu/cisgs/CISGSHOMEPAGE/](http://www.ns.msu.edu/cisgs/CISGSHOMEPAGE/)
APPENDIX B: Clicker questions and inclass exercises

A. A clicker question used to help students visualize molecular processes.

As temperature increases the amount of CO$_2$ gas in solution
A. increases  B. decreases  C. remains the same

B. A box and arrow diagram exercise that students would complete in class. The exercise was presented with two boxes (in bold) already completed. Students must fill in the remaining boxes. The remaining boxes shown here are completed to indicate one correct answer.

There tens of variations on this exercise that can be made by changing the number of boxes or the boxes filled in (in bold).
Appendix C: LON CAPA Homework

1. Read the page on residence time before doing these problems. Which of the following are assumptions implicit in the calculation of residence time?
   a. The outflow is greater than the inflow
   b. All reservoirs are the same size
   c. The inflow is constant
   d. The units of the material in the reservoir must be in grams

2. The volume of water in a pond is 1950 cubic kilometers. A stream running into the pond delivers 3 cubic kilometers of water each year. What is the residence time in years of water in the pond?

3. The volume of water in the oceans is 1340 million cubic kilometers. The annual flux of water to the oceans is 0.45 million cubic kilometers. What is the residence time, in years, of water in the oceans?

4. If the mass of carbon in the atmosphere is 610 times 10^{15} grams and the residence time is 540 years. Assuming the mass of carbon in the atmosphere is not changing (in fact, this assumption is incorrect as we'll see later in the course), what is the annual flow of carbon to or from the atmosphere?
APPENDIX D: FINAL EXAM SS08

ISP203 SS08 Final exam
Multiple choice/true-false questions are 2 points each.

1. Farmer Jones has land next to the Mississippi River that he uses for rice and soybean farming. He hasn’t built a house or barn because the land is only a few feet above the yearly average high water level in the river and it floods at least once every year. Farmer Jones does like to fish so he decided to dig a pond 15 feet deep and stock it with catfish from the river. Farmer Jones wonders about keeping water in the pond. He is not concerned about the water level in the pond rising and lowering a few feet but if the pond dries completely, the fish will die.
   a. He’ll need a system to pump water from the river into the pond.
   b. He won’t need anything because ground water will keep the water level in the pond the same as in the river.
   c. The same rainfall that keeps the river full will keep water in his pond.
   d. Floods plus rainfall will keep the water level in the pond the same as in the river.

2. Houses built on sand dunes along the shore of lake Michigan sit more than 100 feet above lake level, providing spectacular views. People living in the houses get their water from wells on their property. To get water the wells must be drilled to lake level or a bit lower.
   a. True
   b. False

3. When water evaporates, water molecules break a part to form hydrogen and oxygen gas.
   a. True
   b. False

4. Compare water molecules inside a hot pot to the same number of molecules in a cold pot.
   a. The water molecules inside the cold pot are moving slower than the molecules inside hot.
   b. There are more air molecules per cubic meter inside the hot pot than inside the cold pot.
   c. The water molecules inside the hot pot are less dense than those inside the cold pot.

5. There would be no wind if the earth did not rotate about its axis.
   a. True
   b. False

6. Hurricanes slowly die when they move over land because
   a. friction between air and land slows the winds.
   b. the land surface is cooler than the ocean
   c. there is a lack of water to fuel the hurricanes

7. Increased wind velocity due to global warming is leading to upwelling of carbon dioxide rich waters that may degass into the atmosphere. This is an example of
   a. positive feedback
   b. negative feedback
8. How would climate change if the inclination of the earth’s axis or rotation decreased from 23 degrees to 10 degrees?
   a. Spring would come earlier and Fall would come later.
   b. Spring would come later and Fall would come earlier.
   c. Winter would be warmer and summer would be cooler.
   d. Winter would be cooler and summer would be warmer.
   e. None of the above

9. Which of the following is true about most rocks that one might encounter if one were to drill a hole one mile deep into the earth in the middle of Michigan?
   a. they were very likely at the surface at one time.
   b. they originally formed at a mid-ocean ridge
   c. they would contain minerals formed when the earth first formed.

10. In the absence of major ocean currents
    a. polar regions would remain the same but equatorial regions would be cooler
    b. polar regions would be cooler and equatorial regions would be warmer
    c. polar and equatorial regions would be cooler
    d. polar and equatorial regions would be warmer
    e. none of the above

11. If the flux of water into and out of the atmosphere was approximately $10 \times 10^{16}$ liters/year, and the volume of water in the atmosphere was approximately $25 \times 10^{15}$ liters, how would the residence time of water in the atmosphere change if the flux into and out of the atmosphere increased to $15 \times 10^{16}$ liters/year?
    The residence time would
    a. increase
    b. decrease
    c. stay the same because the volume of water in the atmosphere would increase

12. Which of these boundaries is characterized by the deepest earthquakes?
    a. ocean-ocean divergent
    b. ocean-ocean convergent
    c. continent-continent transform

13. Assuming the density of the liquid is the same in all three drawings, which of these three drawings depicts the least dense solid?
14. On planet Gork, the continental crust is 40 km thick and the oceanic crust is 10 km thick. The mantle on which they float has a density of 8. The continental crust has a density of 2 and the oceanic crust has a density of 4. On average, the depth of oceans below the surface of the continents on Gork is between
a. 1-10 km
b. 11-20 km
c. 21-30 km
d. 31-40 km
e. 41-50 km

15. Which of these three types of boundaries would be the location of the least amount of erosion??
a. ocean-ocean divergent
b. ocean-continent convergent
c. ocean-ocean convergent
d. continent-continent transform

16. When water is heated the amount of CO$_2$ gas dissolved in the water will
a. increase
b. decrease
c. remain the same

17. Which of the following rocks would have the most aluminum?
a. limestone
b. shale
c. sandstone

18. Based on the box and arrow diagram below, which reservoirs has the same longest residence time
   a. Biosphere
   b. Hydrosphere
   c. Lithosphere
   d. Atmosphere

   ![Box and arrow diagram with labels and fluxes]

   Units: $10^{15}$ g
   Fluxes = $10^{15}$ g/yr
19. If you collect a glass of water from the mouth of the Amazon, it will contain dissolved ions and small suspended particles of minerals. If you let the glass sit for several days, the water will clear because

a. the mineral matter and ions will settle to the bottom
b. the mineral matter will settle to the bottom but the ions will remain in the water
c. the mineral matter will settle to the bottom and the ions will evaporate.

20. Streams flow into the Great Salt Lake located in the desert southwest, but no water flows out. In some places, the lake has salt (NaCl) on the bottom because.

a. the salt is filtered from the lake water as water seeps into the ground
b. salt ions settle to the bottom
c. salt crystals precipitate from the water.

<table>
<thead>
<tr>
<th>Minerals</th>
<th>Component molecules</th>
<th>Relative bond strength</th>
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<tbody>
<tr>
<td>Quartz</td>
<td>SiO₂</td>
<td>strong</td>
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<tr>
<td>Feldspar</td>
<td>SiO₂, Al₂O₃, CaO, Na₂O, K₂O</td>
<td>strong, weak</td>
</tr>
<tr>
<td>Clay or mica</td>
<td>SiO₂, CaO, Na₂O, K₂O</td>
<td>strong, weak, weak</td>
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<tr>
<td>Calcite</td>
<td>CaCO₃</td>
<td>weak</td>
</tr>
<tr>
<td>Halite</td>
<td>NaCl</td>
<td>weak</td>
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</table>

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<tr>
<th>Igneous rocks</th>
<th>Basalt (extrusive-fine)</th>
<th>Rhyolite (intrusive-fine)</th>
<th>K- and Na-Feldspar Quartz mica</th>
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<tbody>
<tr>
<td>minerals</td>
<td>Ca-feldspar</td>
<td></td>
<td></td>
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<tr>
<td>Sedimentary Rocks</td>
<td>Conglomerate Very coarse</td>
<td>Sandstone Medium grained</td>
<td>Shale Fine to very fine grained</td>
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<td>Detrital</td>
<td>Rock fragments composed of quartz, feldspar and mica</td>
<td>quartz minor feldspar</td>
<td>clays quartz</td>
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<tr>
<td>Sedimentary Rocks</td>
<td>Chemical/biochemical</td>
<td>Limestone Evaporites</td>
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<td>minerals</td>
<td>Calcite</td>
<td>Halite, gypsum</td>
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<tr>
<td>Metamorphic rocks</td>
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<td>Schist fine grained Slate Very fine grained</td>
<td>Marble</td>
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<tr>
<td>minerals</td>
<td>quartz, feldspar and mica</td>
<td>mica, quartz, feldspar and mica</td>
<td>calcite</td>
</tr>
</tbody>
</table>

**Carbon Cycle chemical equations**

1. $6\text{CO}_2\text{(gas)} + \text{H}_2\text{O} \leftrightarrow \text{C}_6\text{H}_12\text{O}_6 + \text{O}_2$
2a. $\text{CO}_2\text{(gas)} \leftrightarrow \text{CO}_2\text{(gas)}$
2b. $\text{CO}_2\text{(gas)} + \text{H}_2\text{O} \leftrightarrow \text{HCO}_3^- + \text{H}^+$
3. $\text{CaCO}_3 + \text{H}_2\text{O} + \text{CO}_2\text{(gas)} \leftrightarrow \text{Ca}^{2+} + 2\text{HCO}_3^-$
4. $\text{CaCO}_3 + \text{silicate minerals} \leftrightarrow \text{Ca-silicate minerals} + \text{CO}_2\text{(gas)}$
1. Complete the diagram

3. a. Draw an analogy between the water cycle and the carbon cycle.
   
b. Based on some aspect of the analog, make a prediction about the target.
   
c. State one way you could test your prediction.

   3. a. Draw an analogy between the water cycle and the rock cycle. This must be different from your answer to number 2.

   b. Based on some aspect of the analog, make a prediction about the behavior of the target.

   c. State one way you could test your prediction.
4. My great Grandfather lived in the desert southwest where he hunted coyotes and sold their pelts. When he died, he was buried under a pine tree. Years later, carbon atoms from dear old grandpa were in a coyote. Draw a box and arrow diagram showing how the carbon may have gone from grandpa to the coyote. Note that the coyote did not dig up grandpa.
APPENDIX E: PEER EVALUATION

COMMENTS ON PROFESSOR SIBLEY’S ISP203A TEACHING PORTFOLIO

Kazuya Fujita
Professor of Geological Sciences
January 19, 2009

Prof. Sibley’s goals for ISP 203A cover the general objectives of integrative studies courses and fall well within the variation in the applications of these goals as implemented by the integrative studies faculty. He recognizes the difficulties that arise with attempting to address the various goals of integrative studies courses with large enrollments – in fact he has had the same transition experience I encountered when I switched from courses of 60-80 to 200 or more. Regardless of what instructional methodologies are applied, some portion – sometimes significant – of the class becomes disengaged, either because of lack of interest (or caring), or because they are lost. Dr. Sibley uses clickers, LON-CAPA, and in-class activities to engage students; however, a student realistically will only be engaged as much as they want to be.

More than most, Dr. Sibley has thought about assessment and learning outcome concerns. As such, the sample questions he provides shows a great degree of depth; however, they are of the short answer variety and may not be easily extended to large enrollment multiple-choice exams.

I attended Prof. Sibley’s ISP 203A lecture on November 18, 2009. This was apparently a lecture preceding an exam, thus it was more of a review and synthesis of previously presented material. He started the class by going over the day’s activities and linking with some readings that had been assigned. He encouraged, and spent a lot of time on, discussions – although the number of students actively participating remains (as expected) small. He does know some students by name and can call on some of them. Goals of this day’s class were made clear and his presentation was clear and understandable from the back of the room.

Much of the class was spent conducting an in-class activity tracing the fate of a carbon atom – much like one of his sample test questions. The material was quite high level for a group of non-science majors and certainly required considerable depth of understanding to execute correctly and without help. Prof. Sibley and his assistant made great efforts to answer questions and guide students along; however, it was impossible to get to all the students and some students end up not requesting or not receiving help. Not surprisingly, some students were tuned out. My experience also has had similar results and to date I have found no better approach. Students who were genuinely interested or willing to participate, however, were engaged at considerable depth. I hope the activity was gone over in a subsequent class or an analysis posted in some form. My primary recommendation is that better results may be obtained if the cycle was handled (if it hadn’t been) as in-class activities in smaller pieces over a series of lectures, and then synthesized in a group discussion.

Two small recommendations are that the lights be dimmed to improve viewing of the powerpoint slides. In addition, some of the print on the slides needs to be made larger – some important legends were difficult to read from the back of the room.
The larger problem of engaging students in a large lecture setting is common to all instructors of such classes. Prof. Sibley has made a considerable effort to allow for discussion and feedback in his class. Undoubtedly, those students who were interested were successfully engaged.