**Department of Geological Sciences May 2010 Addendum to the**

**Fall 2009 Assessment Report and March 2010 Update**

**Compiled by Department of Geological Sciences**

**Submitted by Thom Wilch, Chair**

**May 21, 2010**

The Department of Geological Sciences created a Skills Assessment Matrix for the purpose of assessing skills and knowledge that we expect of our students. The matrix is shown on page two of this document and lists several skill areas that are being assessed in the 2009-10 academic year.

The table below lists the assessment results of eight skill areas that are included in this addendum to our 2009 Assessment Plan and Report. These assessments were carried out during the fall semester 2009. The table also lists one new area of assessment (#9), which needs to be incorporated into our assessment plan. The Department of Geological Sciences has taught Geological Field Methods (Geology 314) in the Rocky Mountains for 40 years. This program recruits students from across the USA and as such it is both a nationally recognized and distinctive program at Albion College. The national recognition of the program is assessed with enrollment data and analysis of US News and World Report ratings of participants’ home institutions, as well as comparative data from other Field Camp programs.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Spring 2010 Goal Areas | Fall 2009 Course or Activity  | Assessment Tool |
| 1. | Communication: Oral Skills | Geology Colloquium | Rubric |
| 2. | Communication: Oral Skills  | Geology 210 | Rubric |
| 3. | Critical Thinking: Critical Reading | Geology Colloquium | Rubric |
| 4. | Critical Thinking: Application of Scientific Method | Geology 103 | Rubric |
| 5. | Critical Thinking: Application of Scientific Method | Geology 101 labs | Rubric |
| 6. | Creativity & Initiative: Independence of thought; integrative thinking; initiative  | Geology 411/412 | Rubric- pilot |
| 7. | Earth Science Methods: Field Skills  | Geology 210 | Rubric |
| 8. | Content Areas: Plate Tectonics | Geology 101 | Exam Questions |
| 9. | Content Areas: 1) plate tectonics and structure; 2) earth history; 3) solid earth composition; and 4) surface and atmospheric processes.  | Senior Exam | Revised exam- pilot |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Goal Areas** | **Courses in Geology Curriculum (2009-10 Version)** |   |   |   |
|   | **101** | **103** | 104 | 106 | 111 | 115 | **201** | 202 | **203** | **204** | **205** | 208 | 209 | 210 | 211 | 212 | 216 | 306 | 307 | 309 | 310 | 311 | 312 | 314 | **Colloquium** | Dir. St. Research  | **Senior Exam** |
|   | **Intro** | **Earth H** | Resources | Hazards | GIS | Oceans | **Structure** | GdWater | **Min** | **Pet** | **Sed Strat** | Geomorph | Paleo | Regional | Rem Sens | Volc | Env. Eng. Geo | Glaciers | Geochem | Vert Pale | Adv Pet | AdvGIS | Ore Deposits | Field camp |
| **Communication** |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Writing Skills | I |   | I | I |   | I | E |   | E | E | E | E | E |   |   | E | E | **E** |   | I | E |   | C | E |   | C |   |
| Oral Skills | I |   | I | I |   | I |   | I | I | E |   |   |   | EA |   | E | E | E |   | E | E |   |   |   | C A |   |   |
| **Critical Thinking** |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Problem Solving | I | I | I |   |   | I | E | C | E | E | C | E | C | E | I | E | I | E | C | C | E | E | E | C |   | C |  |
| Critical Reading  |   |   |   |   |   |   | E | E |   |   |   | E |   | C |   | E |   | C |   |   | E |   |   |   | C A |   |  |
| Quantitative Reasoning | I |   |   |   |   |   | C | E | E | E | I | E | I |   |   |   | E | I | C | I | E | E |   | E |   |   | A\* |
| Application of Scientific Methodology | E**A** | E**A** |   |   |   | I |   | E |   | E | C | E | C |   |   |   | I | E | E | C | E |   | E | C |   | C |   |
| Independent Research | I |   |   |   |   |   |   | E |   | I |   | E | E |   |   |   | E | E | E |   | C | E | E | C |   | C |   |
| **Creativity & Initiative** |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Independence of Thought | I | I | I |   |   |   | I | I |   | E | E |   | E | E |   |   |   | E | E | E | C |   |   | C | C | CA |   |
| Integrative Thinking | E | I | I | I | I | I | I | E | E | E | E | E | E | E | E | E | E | E | C | E | C | E | C | C | C | CA |  |
| Initiative | I | I | I | I | I |   | I | I |   | E | E |   | E | E |   |   | I | E | E | E | E |   |   | C | C | CA |   |
| **Earth Science Methods** |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Field Skills | I |   |   |   | I |   |   | CA |   | E | E | C |   | CA |   |   | I | CA |   |   |   |   |   | CA |   | E |   |
| Lab Skills | I | I |   |   |   |   | E | C | C | C | C | E | E |   |   | E | E | E | C | I | C |   | E | C |   | E |   |
| Map, Imagery, GIS Skills | I | E |   | I | CA |   | E | I |   | E |   | C |   |   | C |   | E | E |   |   | E | C |   | C |   |   | A\* |
| Info. Technology Skills | I |   | I |   | C |   | I | E | I | E | I | E |   |   | C | E | I | E | E | I | C | C | E |   | C | E |   |
| **Content Areas** |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Plate Tectonics | EA | E | I | E |   | E | I |   |   | E | E |   | I |   |   | E |   |   |   | E | E |   |   | E |   |   | A |
| Earth History | I | E |   |   |   | E |   |   |   |   | C |   | C | E |   | E |   | C |   | C |   |   |   | C |   |   | A |
| Solid Earth Composition/Structure  | I | I | I | I |   |   | C |   | C | C | I |   |   |   |   | E |   |   |   |   | C |   |   | C |   |   | A |
| Surface & Atmos. Processes | I | I | I | E | I | E |   | E |   | I | E | C | I |   | I | E | C | C | E | I |   |   |   | E |   |   | A |
| I = topic introduced; E = topic emphasized; C = comprehensively covered |
| A = 2009-10 assessment; A\* = Senior exam and Colloquium Assessments will be expanded to include these areas. Yellow highlight is Fall 09 assessment, pink highlight indicates Fall 09 and Spring 10 assessment; and blue highlight indicates Spring '10 assessment. |

1. **Goal Area- Communication: Oral Skills (Geology Colloquium; Rubric)**

The Geology Department colloquia are held 2:10-3 p.m. on Friday afternoons during both fall and spring semesters.  The colloquia feature presentations by junior and senior geology and earth science majors and minors, as well as faculty and guest speakers. Presentations can be based on 1) independent faculty-mentored research; 2) off-campus geology experience; or 3) a peer-reviewed journal article.  Presentation topic must approved by a faculty member.   It is strongly recommended that students consult with faculty members whose teaching/research is most similar to the presentation topic.

The student oral presentation rubric (below) was completed after each colloquium presentation by all faculty members attending the presentation (n=4-7). The actual rubric sheets also contain areas for faculty to make constructive comments in each of the areas: organization and format: talk content; visual aids. The scores and comments for each student were aggregated and typed up and a copy of aggregate feedback was given to the students

Table 1A. Geology Oral Presentation Rubric

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|   | Excellent = 4 | Good = 3 | Fair = 2 | Weak = 1 |
| Organization and format | Slides are simple, legible and neat. Clear introduction and summary, with well-articulated "big picture" tie-in. Organized talk with very logical progression of ideas.  | Organization and format could be improved in one key area stated in Excellent column.  | Organization and format could be improved in two key areas stated in Excellent column. | Organization and format could be improved in three or more key areas stated in Excellent column.  |
| Talk Content | Thorough knowledge of the topic. Correct pronunciation of terminology. Basic scientific questions are clearly stated and addressed. Assertions are well supported with evidence.  | Talk content could be improved in one key area stated in Excellent column.  | Talk content could be improved in two key areas stated in Excellent column. | Talk content could be improved in three or more key areas stated in Excellent column.  |
| Visual Aids | Figures (photos, graphs, tables) are professional, legible, and neat. Figures are well labeled and include scales. Figures illuminate aspects of the presentation. Text outlines key points appropriately.  | Visual aids could be improved in one key area stated in Excellent column.  | Visual aids could be improved in two key areas stated in Excellent column. | Visual aids could be improved in three or more key areas stated in Excellent column.  |
| Speaker and delivery | Speaker is professional in manner. Conveys concepts in an effective and engaging manner. Vocal projection is clear and audible. Delivery at an appropriate rate and level for the audience. Welcomed and thoughtfully addressed questions.  | Speaker and delivery could be improved in one key area stated in Excellent column.  | Speaker and delivery could be improved in two key areas stated in Excellent column. | Speaker and delivery could be improved in three or more key areas stated in Excellent column.  |

The aggregate scores from both fall 2009 and spring 2010 are presented in the Table 1B. below. In fall 2009, 9 students were assessed using this rubric. One student was evaluated on a completely different trial rubric, which we ultimately decided not to use. In spring 2010, 11 students were assessed using this rubric.

|  |
| --- |
| Table 1B. Compilation of Oral Presentation Assessment Results from 2009-2010 Geology Colloquium. The students are assessed on a 1 to 4 scale (Weak, Fair Good, Excellent) as described in the Table 1 above. N = 11.  |
|   | Fall 2009 Result Summary | Spring 2010 Result Summary |
| Assessment Area | Mean Juniors | Mean Seniors | Mean All | Mean Juniors | Mean Seniors | Mean All |
| Organization and format | 2.93 | 3.31 | 3.14 | 3.40 | 3.55 | 3.50 |
| Talk Content | 3.04 | 3.43 | 3.25 | 3.47 | 3.49 | 3.48 |
| Visual Aids | 2.92 | 3.30 | 3.13 | 3.11 | 3.68 | 3.47 |
| Speaker and delivery | 2.64 | 3.31 | 3.01 | 3.48 | 3.50 | 3.49 |
| Total | 2.88 | 3.34 | 3.14 | 3.36 | 3.56 | 3.49 |

Analysis of results

The fall 2009 semester was the pilot for our Oral Skills Assessment Rubric. Results indicated that senior geology/earth science majors had higher mean scores in each area and overall compared to junior majors/minors. We consider this to be a positive result, since student present multiple times in their junior and senior years. Each student who presented last semester received feedback on their current level in each category with specific comments and suggestions to apply to their next presentation. As this is a new assessment tool it will take several more semesters to evaluate its full impact but we anticipate continued improvement in this area.

The results from the spring 2010 semester show an improvement in both junior and senior presentation scores, especially the juniors. At the beginning of the spring semester, individual assessment results from fall 2009 were handed out to each student. These results included averaged scores and compiled comments from all the faculty evaluators. This may have had two effects on the students. First, for the first time (at least in a formal way), students could understand what faculty value in oral presentations. Second, students received numeric and written comments on their own evaluations. Both of these effects gave students an opportunity to reflect on their presentation skills. We believe that this assessment information helped students improve as pubic speakers. The high scores for some of the students, particularly the seniors, are also related to the fact that many of the students gave presentations at the Elkin Isaac Research Symposium and were very prepared. We plan to continue using this assessment instrument in 2010-11.

1. **Communication: Oral Skills (Geology 210; Rubric)**

The Geology 210: Regional geology course requires that each student give a detailed presentation with handouts on some aspect of the geology that will be examined on the trip. These talks are more in-depth than colloquium talks and often involve the use of several print and on-line references. Presentation topic s are assigned by the faculty based on student course experience and student interests. Unlike colloquium, each student is required to have an in-depth meeting with one or more faculty members prior to the presentation and is required to provide their Powerpoint presentations in advance for review and suggestions.

The same student oral presentation rubric used in colloquium (reproduced below) was completed after each presentation by all faculty members attending the presentation (n=3). The actual rubric sheets also contain areas for faculty to make constructive comments in each of the areas: organization and format: talk content; visual aids. The scores and comments for each student were aggregated and typed up and a copy of aggregate feedback will be given to the students. The faculty summarized each presentation is the table below the rubric.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|   | Excellent = 4 | Good = 3 | Fair = 2 | Weak = 1 |
| Organization and format | Slides are simple, legible and neat. Clear introduction and summary, with well-articulated "big picture" tie-in. Organized talk with very logical progression of ideas.  | Organization and format could be improved in one key area stated in Excellent column.  | Organization and format could be improved in two key areas stated in Excellent column. | Organization and format could be improved in three or more key areas stated in Excellent column.  |
| Talk Content | Thorough knowledge of the topic. Correct pronunciation of terminology. Basic scientific questions are clearly stated and addressed. Assertions are well supported with evidence.  | Talk content could be improved in one key area stated in Excellent column.  | Talk content could be improved in two key areas stated in Excellent column. | Talk content could be improved in three or more key areas stated in Excellent column.  |
| Visual Aids | Figures (photos, graphs, tables) are professional, legible, and neat. Figures are well labeled and include scales. Figures illuminate aspects of the presentation. Text outlines key points appropriately.  | Visual aids could be improved in one key area stated in Excellent column.  | Visual aids could be improved in two key areas stated in Excellent column. | Visual aids could be improved in three or more key areas stated in Excellent column.  |
| Speaker and delivery | Speaker is professional in manner. Conveys concepts in an effective and engaging manner. Vocal projection is clear and audible. Delivery at an appropriate rate and level for the audience. Welcomed and thoughtfully addressed questions.  | Speaker and delivery could be improved in one key area stated in Excellent column.  | Speaker and delivery could be improved in two key areas stated in Excellent column. | Speaker and delivery could be improved in three or more key areas stated in Excellent column.  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Category | Excellent in all or most areas | Excellent to Good in all areas | Good | Fair or Weak |
| Range | 16-15 | 14-13 | 12 | 11-4 |
| No. of students | 7 | 8 | 2 | 1 |

Analysis of results

Of the 18 students evaluated, seven (39%) were assessed to have given excellent talks with excellent handouts. In each case, the student averaged a 4 in at least 3 of the 4 categories. In eight cases (44%), students were judged to have averaged 3 or 4 in all areas. In two cases (11%), the students averaged a 3 in all areas, with some sub-scores in the 2 or 4 categories. Only one student (6%), scored poorly (fair or weak) in all categories. Although this student is visually impaired and giving a talk was challenging for him, most of the poor ranking was due to his very poor speaking style and inadequate preparation for the talk.

The overall strong results are a reflection, in part, of the stringent structure and rules provided for the students in this course. However, several encouraging trends are of note. All four graduating geology seniors were evaluated at the highest level, each having had the experience of giving four colloquium talks previously. Of the five junior geology majors, two were ranked at the highest level and the three other at the second level (Excellent to Good in all areas). These students have all given two colloquium talks previously. Among sophomores and First-Years (who have not given colloquium talks yet), one was ranked at the highest level, 4 were ranked at the second level, and the remaining three were ranked at the Good level or below. It seems clear that colloquium is providing our students with excellent training in giving well-presented, well-researched, and informative talks.

It is recommended that we continue to track the scores of our students giving regional talks in the future and that the structure for talk preparation and review be standardized for Regional Geology so that accurate comparisons can be made for our students as they progress through the program.

1. **Goal Area- Critical Thinking: Critical Reading (Geology Colloquium; Rubric)**

We used the same student oral presentation rubric to assess critical reading skills. In this case we only used the Talk Content category to assess the critical reading skills. Presentations were based on 1) independent faculty-mentored research; or 2) a peer-reviewed journal article.

Table 2. Compilation of Critical Reading Assessment Results from 2009-2010 Geology Colloquium. The students are assessed on a 1 to 4 scale (Weak, Fair Good, Excellent) as described in the Table 1A above.

|  |  |  |
| --- | --- | --- |
|   | Fall 2009 Result Summary | Spring 2010 Result Summary |
| Assessment Area | Mean Juniors | Mean Seniors | Mean All | Mean Juniors | Mean Seniors | Mean All |
| Talk Content | 3.04 | 3.43 | 3.25 | 3.47 | 3.54 | 3.52 |

Analysis of results

Results indicate that senior geology/earth science majors and minors had higher mean scores as compared to junior majors/minors. There were similar improvements to those discussed in the previous section on oral presentation. Critical reading skills are practiced in several upper-division geology courses and in all research projects. The results are frequently presented in colloquium presentations. In our new rubric we can provide specific feedback to students on their current level, areas to target for improvement and areas where they are already strong. In our March assessment update, we anticipated continued improvement in this area, and this was borne out this semester. The fact that four of the seniors did senior theses also helped their individual scores.

**4. Critical Thinking: Application of Scientific Method (Geology 103; Rubric)**

The "Scientific Analysis" mode assessment focuses on the following learning goal: Test hypotheses or other scientific theories. For Geology 103, I decided to assess student’s understanding and application of observation, hypothesis development, and hypothesis-testing as it applied to a group of extinct reptiles they had learned about in lecture. The project involved the examination of two skeletons of flying reptiles (pterodactyls) hanging in the Science Complex Atrium, which was part of a larger laboratory examining dinosaurs and other fossils on display in the Science Complex. Students worked as individuals or in groups of 2 or 3. Scientific methodology and hypothesis testing is described in their textbook and in lecture without specific reference to the problem.

The learning goal is assessed in the ability of the students to develop three hypotheses explaining the differences between the two skeletons and the evidence they would seek in closer examinations of the skeletons, the records of where they were found, or specimens in other museums. I evaluated the 41 students according to the table below.

|  |  |
| --- | --- |
| # Students | Description of Rating |
| 1 | Student was unable to formulate a reasonable and testable hypothesis. |
| 40 | Student posed at least one reasonable and testable hypothesis  |
| 37 | Student posed at least two reasonable and testable hypotheses  |
| 24 | Students posed three reasonable and testable hypothesis |
|  |  |
| 4 | Student could construct no adequate tests for any hypothesis |
| 37 | Student could construct at least one adequate test for any hypothesis |
| 37 | Student could construct at least two adequate tests for any hypotheses |
| 8 | Student could construct three adequate tests for all hypotheses |

The conclusion from this assessment is that with a single exception, all of the students could formulate a reasonable and testable hypothesis explaining the differences in the skeletons. In addition, 90% (37/41) were able to formulate two hypotheses and 59% (24/41) were able to formulate three. In terms of testing their hypotheses, less than 10% could not construct a single adequate test for any hypotheses, regardless of how many they may have formulated. However, 90% (37/41) of the students were able to construct two adequate tests. Finally, 20% (8/41) were able to provide sound tests for all three of their hypotheses.

**Outcomes and Conclusions**

The students were not graded on this exercise, although they did not it at the time. The single student who was unable to formulate a single hypothesis had been disengaged throughout the class and put little effort into anything. I am unwilling to put much inference on his outcome.

Three additional students, working as a group, were not really able to formulate original ideas. Their single hypothesis was straight out of their lecture notes on another group, and their proposed tests were generally unrelated fragments of knowledge gleaned from other parts of their lecture notes. I am not sure how to assess their performance.

All remaining students could formulate and test at least two hypotheses.

The students who were successful at the two hypothesis & test level, were able to take information given on related retile groups and apply those methodologies and observations to the pterodactyls. The students who could formulate the third hypothesis were able to take more abstract concepts from the course and apply them here. Their ability to then formulate a test of that third hypothesis was fairly limited however, with only 8 of the 24 (33%) suggesting an adequate test.

Knowing that I would be conducting this assessment, I was very careful to avoid direct reference to how to test hypotheses in these situations. Later in the course, I go through a detail analysis of another group of reptiles to illustrate hypothesis testing, but it comes after they have completed this assessment.

Given the fact that 60% could come-up with an original third hypothesis but 2/3 of them not an original test, I feel that I can give them greater insight into this project by introducing multiple hypothesis testing in an earlier lab exercise, perhaps using an invertebrate fossil group such as trilobites. I will, therefore, repeat the exercise in the Fall of next year.

I have designed a different assessment for hypothesis formulation and testing for this semester that will use a similar methodology but use dinosaurs instead.

1. **Critical Thinking: Application of Scientific Method (Geology 101 labs: Rubric)**

One of the Geology Department’s learning goals is application of the scientific method, which is also one of the "Scientific Analysis" mode learning goals (to test hypotheses or other scientific theories). The "Scientific Analysis" mode assessment focuses on the following learning goal: Test hypotheses or other scientific theories.

For Geology 101, the faculty teaching the course and laboratory (McRivette, Menold, Van de Ven in fall semester; and Tim Lincoln, Van de Ven, and Wilch in spring semester ) assessed students’ understanding and application of hypothesis-testing in group student research projects that are a component of the lab. The research projects are introduced in the lab manual (Attachment #1) and detailed in lab handouts (Attachment #2). The scientific method was introduced in lecture early in the semester, is described in the course textbook, and was discussed in lab sessions in conjunction with introduction of the research projects. In the fall the project is carried out early in the semester; in the spring the project is at the end of the semester.

The learning goal is assessed in the reports associated with the research projects. Students were told to pose a testable hypothesis and to test it with their research. In spring 2010, all 55 enrolled students completed research project reports. The Geology Assessment update submitted in March discussed the fall assessment results. Here we present the fall and spring results, as well as the combined results from the 2009-10 academic year. Understanding of hypothesis-testing was assessed on a 4-point scale, according to the table below.

**2009-2010 Geology 101 Scientific Analysis Assessment Summary Table**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|   |   | Fall 2009 | Spring 2010 | combined 2009-10 |
| Rating | Rating Description | no. stu. | % | no. stu. | % | no. stu. | % |
| 0 | Students failed to mention their hypothesis in their papers | 2 | 3.9% | 2 | 3.6% | 4 | 3.8% |
| 1 | Students posed a hypothesis but did not adequately test it, the quality of the hypothesis was so weak that it was difficult to test | 12 | 23.5% | 7 | 12.7% | 19 | 17.9% |
| 2 | Students posed a hypothesis and tested it adequately, the quality of the hypothesis was acceptable but tended to be a little to general to be tested adequately in lab study | 22 | 43.1% | 38 | 69.1% | 60 | 56.6% |
| 3 | Students posed a hypothesis and tested it, and posed a follow-up hypothesis, the quality of the hypothesis was high and was appropriately tested | 15 | 29.4% | 8 | 14.5% | 23 | 21.7% |
|   | total number of students (n) | 51 | 100% | 55 | 100% | 106 | 100% |

The 4-point rating scale is not linked directly to the grading of the papers, although there is a correlation in that students who failed to mention a hypothesis most likely omitted other important aspects from their papers.

Our conclusion from spring assessment is that 96% of the students (53/55 students) understood the concept of a hypothesis (rating > 0). Examples of reports earning a rating of “0” are available upon request. A total of 84% were able to successfully test their hypothesis through independent research (rating > 1). A total of 14.5% (8/55 students) understood the iterative process of hypothesis-testing that is an important extension of the scientific method (rating = 3). Examples of reports earning a rating “3” are available upon request.

## In the March Assessment Update, it was suggested that a goal of 80% attainment of a 2 or higher rating is an appropriate target at this juncture. It was stated that the “existing procedures for introducing and emphasizing the scientific method are sound, but may benefit from the addition of a document to be provided to students in lab as part of the research project that reinforces the components of scientific methodology.” In the spring, the handout given to students that introduced possible projects included a generic description of the scientific method. It was not the focus of professors’ introduction to the projects but was available to students. We met our goal of 80% attainment of a 2 or higher rating, with a total of 84% of students in this category.

## In light of these results for Geology 101, an introductory level science course that serves a large portion of the student body in meeting their scientific mode requirement, it seems appropriate that we should continue to maintain the 80% goal for the number of students rating 2 or higher according to the scale used for this assessment but work on increasing the number of students that achieved the highest rating of 3. Overall in 2009-10, 22% received a rating of 3 or higher; we suggest that a goal of 30% attainment of this rating is an appropriate target at this juncture. The existing procedures for introducing and emphasizing the scientific method are sound, but may benefit from working more closely with groups to discuss what the hypothesis-testing means in the context of their specific projects.

## Attachment 1: Lab Manual Assignment Description

## Weeks 4, 6, and 11: Introduction to Group Research Projects

General Requirements

Research is fundamental to science, so it is our belief that research belongs in an introductory science course. We are asking (and would rather think of it as inviting) you to complete a research project this semester. Past students have found that the ability to work independently, in groups, outdoors, and on a project of their own choosing and design have made this an enjoyable part of the course.

We have the following requirements that the research project must:

* be a group effort
* be geological
* be based on the scientific method and involve formulating a hypothesis, and collecting and interpreting data to test the hypothesis

Read the In Greater Depth 1.4 Box (p. 22-23) for a review of the Scientific Method.

Schedule

You will work on this project both in scheduled lab time and on your own time. This week, we will devote time in lab to discuss the various possible projects and several of the techniques available to you. The group will be required to prepare a prospectus of the research project. The prospectus should include the following:

* the problem to be solved (the question you hope to answer)
* a hypothesis or hypotheses
* the basic design of the project (how many measurements or samples will be collected, where, why; how samples will be analyzed)
* how the results will be interpreted (what are you looking for, what will support one conclusion over another)

The project will require completion over period of time and will likely involve travel and field work. You will have several weeks to complete the necessary work before the due date (Week 11-12). Please note that, while we have scheduled a lab for work on the project, *you will almost certainly find it necessary to devote additional time outside of lab to complete the sample collecting, lab analyses, etc.* It is therefore critical that you make steady progress between now and the due date – do not put off field work that may not be possible to complete later in the semester when weather may interfere, or wait until the last minute to schedule analytical time. We will be very happy to help you and we will need to assist with some aspects of the research project. It is your responsibility to request help, ours to give it.

Final Report

Each member of each group will write a short paper describing the project and its results. This must be in your own words – it is an individual, not a group, product. The results of the project will be presented in class on the day indicated on the syllabus. Both papers and presentations should include maps, charts, text, etc. More details about the presentation will be given.

Papers are due on the day of the presentation and should follow the outline below:

Introduction: describing the objectives of the project and the hypothesis(es)

Methods: describing how data was collected

Data: the “facts” consisting of maps, tables, graphs, text, etc., describing the data

Interpretations: analysis of the data explaining what it means and an evaluation of possible sources of error

Conclusions and recommendations: summary statement (bulleted is okay) of the research and hypothesis test results, and recommendations for further research

Evaluation of group work: an honest assessment on the “group” experience: What was each person’s role in the project? Was the work distributed evenly?

*Additional information will be presented in lab.*

**Attachment #2: Project Descriptions**

1. Broad-scale view of the Kalamazoo River hydrology

Chris Van de Ven, cvandeven@albion.edu, will help with this project

This group will examine the hydrology along a broad length of the Kalamazoo River. Your primary tools for study will be online stream gage and historical data, complemented by field observation and documentation of the stream gage locations. The USGS maintains a series of stream gages on the Kalamazoo River.

Background data you need to acquire include:

* Locate the 3 closest stream gages to Albion on the Kalamazoo River
	+ Plot them as placemarks on a Google Map or Google Earth
* You will research what data these stream gages record and what they mean
	+ What is the discharge and stage height at flood level?
	+ What is the watershed area for each gage?
	+ What is the relationship between watershed area and base flow?
* Evaluate the historical records they have recorded
	+ Including the flood-recurrence interval graphs
	+ What is the recurrence interval for flooding?
	+ What is the recurrence interval for
* How do landuse and landcover affect stream characteristics and responses to precipitation?
* Others??

Some ideas for your project include…

* Visiting the 3 closest stream gages
	+ Photograph each stream gage
	+ Record the river and channel characteristics upstream and downstream of the gages
	+ Record the landuse patterns at the gage as well as up- and downstream
* Monitor and graph stream levels
	+ What is the baseflow at each gage?
* Record the timing and size of precipitation events
	+ Determine the rate of response at each gage
* Create a topographic profile across the floodplain at each gage
	+ How does it change downstream?
* Calculate the river gradient for each section of river.
* Others??
1. Heavy metal contamination of soils due to urbanization, industrial uses, and/or agricultural practices

Carrie Menold, cmenold@albion.edu, will help with this project

There are many possible sources of contamination urban soils. It usually suspected that heavy industry, landfills, and major chemical spills are the major causes of contamination of the environment. However, it is also quite likely that much contamination comes from personal and residential use of common materials. One example is lead contamination resulting from weathering of old (pre-1978) paint (lead-based). Such sources of contamination can be insidious. They are widespread, and thus difficult to contain. Often, there is no obvious culprit to blame and require to clean up the mess. In rural areas, agricultural practices, particularly the application of certain pesticides and fertilizers, can result in accumulation of heavy metals in the soil. This group will study the heavy metal content of soil samples to investigate possible sources and causes of contamination. This project entails:

* designing a sampling strategy to test your hypothesis. This should include control samples (samples from non-contaminated locations).
* preparing soil samples for analysis, by grinding and pressing pellets using special machines available in the department.
* analyzing samples using the automated x-ray fluorescence (XRF) spectrometer in the Dow Lab to determine heavy metal concentrations in your samples.
* preparing maps and charts to evaluate your results.

**Local hydrology of the Kalamazoo River**

Mick McRivette, mmcrivette@albion.edu, Putnam 256, will help with this project

This group will examine the hydrology along the Kalamazoo River near Albion. Primary tools for this study will be stream velocity meters (from which stream discharge can be obtained) and analysis for the total suspended sediment load carried by the river, complemented by field observation and map analysis and interpretation. The USGS maintains a series of stream gages on the Kalamazoo River, but none in the Albion area.

Stream discharge will change along the length of a stream due to the influence of tributaries and exchanges between surface and ground water. Discharge is also sensitive to seasonal climate variations and short-term weather perturbations. The amount of suspended sediment transported by a stream may vary with stream velocity, which is itself related to discharge and its contributing factors, especially short-term weather variability. In addition to data collected in the field, you will have access to USGS 7.5” topographic maps of the Albion area.

This project entails:

* studying local maps and designing a measuring/sampling strategy (several locations along the stream) to test your hypotheses.
* using the current velocity meter, measuring tape, and graduated rod to measure stream velocities and channel dimensions at measuring/sampling locations.
* calculating discharge for each of your cross-sections.
* collecting and analyzing samples to find sediment load transported by the stream at measuring/sampling locations.
* evaluating your hypotheses about the predicted changes in discharge and sediment load along the stream (and possibly associated tributaries) based on your results.
1. **Creativity & Initiative: Independence of thought; integrative thinking; initiative (Spring 2010, Geo. 411 (0.5 unit directed studies- Rubric- Pilot). 8 Students**

The rather subjective “skills” of independence of thought, integrative thinking, and initiative were assessed in Spring 2010 through directed studies. Eight students undertook directed studies supervised by a Geology faculty member. Of those eight, six were Geology majors, 1 was a Biology major, and 1 was a Computer Science major. Two of those directed studies were completed as part of the requirements for the GIS minor (Geology and CS majors), and four were for the completion of an honors thesis (either departmental or college honors). Five of the eight the directed studies were completed by seniors in their final semester.

Late in spring semester 2010, we developed a rubric for assessing the three skill areas:independence of thought, integrative thinking, and initiative. As a department we have discussed the difficulty of evaluating directed studies because, unlike classes, each one is unique. These rubrics presented here are the first step in establishing a department standard for performance in directed studies. In fall 2010, we will discuss linking these evaluations to grades. There may be other criteria that are included in student evaluation but independence of thought, integrative thinking, and initiative will likely be included in evaluation criteria for directed studies and independent research experiences. In fall 2010, students enrolled in directed studies will be given copies of the rubrics to help them better understand some of the overarching goals of independent study experiences.

**Independence of Thought**

|  |  |  |
| --- | --- | --- |
| Rating | Description | No. |
| 0 = unacceptable student-level  | The student makes no research decisions. The advisor makes all decisions regarding research concept, methods, analysis, conclusions, and significance. If the student does make some research choices, they are poorly reasoned, and must be wholly revised or rejected by the advisor. |  |
| 1 = weak student-level  | Student makes few research choices. Most research decisions come with prompting from the advisor. Once given a suggestion or direction, the student infrequently makes wise or informed choices regarding their research direction, significance, or conclusions. | 2 |
| 2 = satisfactory student-level  | Student makes many choices regarding the direction, significance, meaning, and conclusions of their directed study project, but most of those choices come with input, clarification, and/or suggestions from faculty advisor. Most student research decisions require refinement, direction, and/or prompting from the advisor, but student does make some (but not all) research decisions. | 3 |
| 3 = strong student-level  | Student is able to make good decisions on the direction, significance, meaning, and conclusions for some aspects of their directed study project. Student research choices are generally well thought out and self-driven, but may need minor refinements by faculty advisor.  | 2 |
| 4 = High-level Graduate student | Graduate student level. Student regularly makes informed and intelligent decisions about the direction, significance, meaning, and conclusions for most aspects of their directed study project. The student is able to make wise research decisions on their own.  | 1 |

The independence of thought evaluates students’ requirements for supervision in most aspects of their research. Are students able to develop a sound research strategy? Do they need abundant guidance and re-direction?

**Analysis of Results**: Student performance ranged from high-level graduate to weak. Only 2 of the 8 students were weak, with the remaining 6 students satisfactory or better. Weak students had few or no ideas of their own, and were mostly advisor-directed. Satisfactory students had some good ideas that needed refining, and when given direction, could take that direction and apply it. Strong students had many of their own ideas, sometimes needing refinement or minor re-direction. The graduate-level student’s research direction and plans were almost entirely student-derived and well-reasoned, requiring only minor modifications by the advisor.

The students completing theses were all satisfactory or better, with the largest number at “strong”, partly due to the time spent with their research topic.

**Integrative Thinking**

|  |  |  |
| --- | --- | --- |
| Rating | Description | No. |
| 0 = unacceptable student-level  | Even with instruction, the student is unable to relate their project to the “big picture” and is not able to apply knowledge, methods, or analyses from more than one discipline or point of view. |  |
| 1 = weak student-level  | Student struggles to understand how their research fits into the “big picture,” and has difficulty applying a diverse set of tools and analyses to bear on their project without significant instruction. | 1 |
| 2 = satisfactory student-level  | Student relates their research to the “big picture” with some additional research and prompting. The student can apply methods and analyses from various disciplines to their own research with prompting and minor instruction from their advisor. | 4 |
| 3 = strong student-level  | Student understands how their research fits into the “big picture” and applies methods, knowledge, and analyses from multiple disciplines to their project with minimal direction from the advisor. | 3 |
| 4 = High-level Graduate student | Graduate student level. Student regularly makes connections between different aspects of their research, is able to tie their project into the broader scientific community, and can appropriately use methods and analyses from a range of fields and backgrounds.  |  |

Integrative thinking assesses students’ abilities to understand how their project fits in the “big picture,” understanding the significance of their research and how it is related to other disciplines within, and outside of geology. This assessment evaluates how well students can incorporate ideas presented in diverse sources, classes, and even disciplines in their project.

**Analysis of Results**: Students were generally able to put their project into a broader context. Seven of the 8 directed studies were “satisfactory” or “strong.” The one student that showed “Weak” integrative thinking did not show that he understood the basic science behind his project. “Satisfactory” students needed some guidance, occasionally had to ask for clarification regarding the significance of their project, but were generally capable of understanding methods and applying concepts from literature and courses to their project. The “Strong” students initiated methods or explanations from a variety of sources and disciplines, and understood the importance of their project.

**Initiative**

|  |  |  |
| --- | --- | --- |
| Rating | Description | No. |
| 0 = unacceptable student-level  | The project did not reach its goals primarily because the student did not take the time or effort to complete the work. In most cases, the work that was completed was finished in the last week or two of the semester due to the student’s lack of drive to make regular progress on his or her directed study. |  |
| 1 = weak student-level  | The advisor regularly has to remind the student to accomplish tasks. The student frequently puts off work for later, requiring more time to be devoted to the project at the end of the semester. Most of the work in this directed study is accomplished in the last few weeks of the semester due to the student’s inability to complete tasks earlier. | 1 |
| 2 = satisfactory student-level  | The project is completed with a time-table mostly established by the advisor, but, once established, the student occasionally needs to be pushed to complete tasks from the advisor. Somewhat more than half of the work is accomplished in the second half of the semester. |  |
| 3 = strong student-level  | The student requires minimal or very infrequent pushing from the advisor to accomplish tasks. Research tasks are accomplished rapidly and skillfully. This student’s directed study is mostly student driven. The work in this directed study is spread throughout the semester, and does not require an inordinate amount of effort to complete at the end of the semester. | 6 |
| 4 = High-level Graduate student | Student actively pushes the project forward. Little or no pushing is required of the advisor. The student accomplishes tasks accurately and skillfully in a rapid time frame on his or her own initiative. This student’s directed study is almost entirely student-driven. The work in this directed study is spread throughout the semester, and does not require an inordinate amount of effort to complete at the end of the semester. It may have been completed ahead of schedule. | 1 |

Initiative assesses students’ drive and ability to complete their project. This incorporates students’ abilities to make regular progress throughout the semester, their general enthusiasm for their project, and how well they were able to accomplish tasks.

**Analysis of Results:**  A majority of students, 6 of the 8, were “Strong” in their initiative, 1 showed “Weak” initiative, and 1 was at “Graduate-level.” The “Strong” students all completed their research by making regular progress throughout the semester. They worked hard and accomplished their tasks. The “Weak” student completed most of the work at the end of the semester and only made adequate progress due to poor time management. The “Graduate-level” student worked very hard to accomplish tasks with no pushing required from her advisor. She kept up that rigorous level throughout the semester, and was able to accomplish her research and writing ahead of schedule.

**7. Earth Science Methods: Field Skills (Geology 210; Rubric- pilot)**

An assessment of field note-taking was completed for Regional Field Geology (Geo 210) in Spring 2010. The same rubric was used in the Fall 2009 for the Glaciers and Climate Change (Geology 306). Taking thorough and accurate notes in the field is a difficult but critical task in geology. Observations, measurements, data collection, and interpretations are best recorded at the exposure. This rubric is designed to be used to assess field note-taking by students who are making independent geological

|  |  |  |
| --- | --- | --- |
| Rating | Description | No.  |
| 0 = unacceptable student-level notes  | Notes are illegible and incomplete. Basic site information (location, date, time, weather, purpose) is very weak or absent. Key observations and sketches are critically flawed. No interpretations/hypotheses or confusion of observations and interpretations. Notes are flawed and would not be useful to other geologists who have not visited the site. | 1 |
| 1 = weak student-level notes | Notes are mostly legible but lack organization and consistency. Site information (location, date, time, weather, purpose) is weak and lacking important points. Key observations and sketches are lacking important information or clarity. Interpretations/hypotheses are weak and may be confused with observations. Notes are lacking in multiple areas and would be only marginally useful to other geologists who have not visited the site. | 0 |
| 2 = satisfactory student-level notes | Notes are legible and moderately organized. Site information (location, date, time, weather, purpose) is acceptable but not complete. Key observations are included but detail could be improved. Sketches of site, exposure(s), and features are included but could be improved in clarity, labeling or scale. Interpretations/hypotheses are included but are not well supported by observations. Notes lack detail but would still be useful to other geologists who have not visited the site. | 9 |
| 3 = strong student-level notes | Notes are legible and reasonably well-organized. Site information is complete (location, date, time, weather, purpose). Observations are appropriate to exposure or site and are mostly thorough. Sketches of site, exposure(s), and features are clear and have appropriate labels, directional indicators. and scale. Interpretations/hypotheses are included and supported by observations. Notes would be clear and useful to other geologists who have not visited the site. | 8 |
| 4 = professional-level notes | Professional level. Notes are legible and well-organized. Site information and observations are detailed and complete. Thoughtful and, in some cases, multiple interpretations/hypotheses are included in notes and clearly separated from factual observations. Notes would be very clear and useful to other geologists who have not visited the site. |  |

No. refers to the numbers of students who were evaluated at each rating level.

observations or collecting original data in the field. The five point rating scale is not linked directly to the grading of the field notebooks, although there is a rough correlation. Field notes are emphasized in several upper level geology courses and are comprehensively covered in our summer field camp course, Geology 314: Geological Field Methods. It is our expectation that prior to field camp, students will be taking notes at a satisfactory level. Field camp students should ultimately be performing at a strong to professional level.

Students were assigned field notebook grades based on the specific criteria that related to the field trip through the Appalachians into the Rift Basins and Coastal Plain of New Jersey. Their note-taking was based on outcrop descriptions and interpretations as well as specific field assignments. Student notes were also assessed according to the following more general rubric. The grades and assessment were aligned. This course enrolled 18 students.

Analysis of Results:

This was the second time that this rubric has been used to evaluate student’s ability to take field notes. Students were instructed in note-taking at the beginning of the course and at several points throughout the course. There were approximately 40 outcrop stops and two field exercises conducted during the eight-day field trip. The field assignments involved making observations, collecting data, and interpreting the origin and significance of the outcrop or series of outcrops.

The instructors made suggestions on the notes several times throughout the course but the notebooks were graded only at the conclusion of the trip. This is not an advanced course in geology, but rather a 0.5 unit course open to students who have completed anything ranging from a single geology lab course (Geology 101 or 103) to students having completed a G-Track (grad school prep) Geology Major. The students included First-Years to Seniors, mostly geology majors, but also a non-major and an earth science education student. The mode (9/18) evaluation score was a 2, which indicated satisfactory student-level notes, but with a single exception (discussed below), all students were evaluated at either the satisfactory or strong student-level notes ranking. Among graduating senior geology majors, all four were ranked in the strong category. Junior geology majors (n=5) all ranked in the satisfactory category, and the six sophomores were evenly split between satisfactory and strong . The First-Year student was rated as having strong note-taking skills.

The results are somewhat difficult to assess due to the varied backgrounds of the students. Upper division courses in geology range from being field-intensive to having no field component. As evidenced by the high evaluations of the First-Year student and some of the sophomores, field work (and field note-taking) is a skill that is readily acquired by some students, but very difficult for others. It is important to note, however, that all graduating senior geology majors took notes at the highest level expected for undergraduate geology students.

The single student who ranked below the satisfactory level is vision-impaired. We required that he take his own notes during the trip even though he has a note-taker on-campus. The student was provided large-scale drawings of many of the geologic features seen throughout the trip, and these helped him get more out of the trip. In terms of this assessment exercise, however, his limited ability to make observations in the field and his inability to write clearly or quickly, severely the potential for him to produce field notes that measure-up to the standards we have set. We will continue to work with the student to develop more appropriate means and assistance for him to participate in field work in the future.

Two suggestions to improve the assessment are: 1) to systematically assess the field notes on two or more occasions during the students careers; and 2) to include an analysis of how many field-note intensive classes each student has taken prior the current course. The data on the relationship of courses taken to effectiveness of field observations , interpretations, and note-taking are becoming available, and will be evaluated in future assessment updates. In addition, two specific assessment exercises were conducted during the trip, and these results will be processed and provided in the next assessment update.

 It is anticipated that use of this or similar rubrics in other field intensive courses will result in more intentional teaching of note-taking skills and an overall improvement in note-taking quality.

1. **Content Areas: Plate Tectonics (Geology 101; Exam Questions)**

Student mastery of the ‘Plate Tectonics’ content area was assessed in one of two sections of Geology 101 (Introductory Geology) in spring 2010 and was also assessed in fall 2009 (see Geology Assessment March update). Plate tectonics is the ‘unifying theory’ of modern geology and forms the fundamental framework for many of the specific concepts covered throughout the course. As such, a significant portion of the course is devoted to the exploration of plate tectonic theory directly, while the plate tectonic context of other concepts is routinely emphasized throughout the remainder of the course. It is the single most important content area presented in Geology 101.

In spring 2010, assessment of the plate tectonic content area was performed through a final exam problem. The theory of plate tectonics was introduced during the first week of class and was on the first exam (no assessment results are available.) The theory was also covered in the final two weeks of class. The students were told that the final exam would include a question that required students to draw a plate tectonic cross-section. In the study guide, students were given several possible questions: including draw a cross-section from New Jersey to Spain; draw a cross-section from the Indian Ocean to central Asia; or draw a cross-section from Chile to Japan. In the first exam the students were asked to draw a generic cross-section that depicted an ocean-continent convergent boundary. The question from the final exam is provided below:

*From final exam:*

Draw a plate tectonic cross-section from South America to Japan. Locate and label the plate boundaries. List one place (country, ocean) where you find each of the three boundaries. Label the following features in your sketch:

abyssal plain

accretionary wedge

aesthenosphere

basins

crust

lithosphere

volcanoes

earthquakes

mantle

mid-ocean ridge

rift valley

seamounts

trench

sites of metamorphism

arrows indicating relative plate mot

**Results and Analysis:**

This final exam question was worth 20 points in a 150 point exam. The scores ranged from 8/20 to 20/20; the mean score was 16/20. The mean score for the 28 students met the 80% target that established for fall semester assessment of the plate tectonics. The score distribution for the final exam problem is shown in the scatter plot below.

Of the 28 students that attempted the final exam problem, 19 students (68%) met or exceeded the 80% threshold. Six students (21%) received scores of 60% or lower.

In the analysis of fall 2010 assessment results, it was suggested that plate tectonic theory receive in-depth coverage in Geology 101 as early as possible within the course structure. This was done in the spring semester. The slightly higher scores in spring may also have resulted from a very explicit expectation that students be able to draw and explain the plate tectonics cross-sections on the final exam. During one of the final classes, students spent 15-20 minutes drawing different cross-sections as an in-class exercise. In many ways, geology is a very visual science and being able to construct visual models of key parts of the earth system is an important skill that we want our students to develop.

1. **Content Areas: 1) plate tectonics and structure; 2) earth history; 3) solid earth composition; and 4) surface and atmospheric processes. (Senior Exam; Pilot)**

For the past 7 years, we have administered a senior exam to graduating Geology and Earth Science majors to assess whether they have obtained a comprehensive understanding of the geological sciences. Because standardized tests do not exist, the exam is written by members of the department. This year, we administered a completely revised version of the senior exam. The “old” exam was constructed with multiple-choice questions from Geology 101 and 103 final exams. This exam was general and not designed to meet standard specific learning goals. In places the exam covered material that was not covered in any subsequent courses, required by students.

When we originally designed the old exam, we established the following expectations: ninety percent of seniors will be able to answer 70% of exam questions, 67% of seniors will be able to answer 80% of the exam questions, and 33% will be able to answer 90% of the exam questions. Overall, students fell short of meeting the goals, with 75% (vs. 90%) scoring 70% or higher, 55% (vs. 67%) scoring 80% or higher, and 13% (vs. 33%) scoring 90% or higher. It was difficult to remedy the underachievement because the old exam was not linked to specific content goals but only with general non-specific content goals. The questions were not categorized. In short the exam allowed us to assess overall comprehension but did not allow us to address shortcomings in comprehension.

This year we developed a new exam that mirrors our stated learning goals. The exam has a variety of question styles, including multiple-choice, fill-in-the-blank, story problems. The test asked students to interpret text, sketches and graphs, analyze maps, and to identify rock and mineral samples. Questions were categorized and assessed according to the following learning goals:

Content Assessment Areas: plate tectonics and structure, solid earth composition, surface and atmospheric processes, and earth history.

Skill Assessment Areas: quantitative reasoning and map reading skills

In designing our departmental assessment plan, we anticipated that we would assess two additional areas on the senior exam: integrative thinking and problem solving. After working collectively on designing the new exam, we decided that these skill areas are probably better assessed through class-based projects and laboratory experiences, rather than in a time-limited exam.

**Senior Exam Assessment Goal.** We consider this year a pilot year for the senior exam. For this year we are maintaining the same expectations as in previous exams: 90% percent of seniors will be able to answer 70% of exam questions, 67% of seniors will be able to answer 80% of the exam questions, and 33% will be able to answer 90% of the exam questions.

**Senior Exam Assessment** **Results.**  We administered the new senior exam on April 30, 2010 to five of six seniors; all were invited to take the exam. The exam took 45 minutes to 1.25 hours. A copy of the new exam is attached to this report. The scores ranged from 78.4 to 89.2 %; three students scored in the 80-90 percentile. Overall the students met the stated goal of 90% of students getting a 70% or higher score. The students fell short of the goal of 90% or higher by 33% of the students. The summary results are presented in the table below:

2010 Senior Exam Results

|  |  |  |  |
| --- | --- | --- | --- |
|  | Content Areas | Skill Areas |  |
|  | Plate tectonics/ structure | Solid Earth Comp. | Earth History | Surface/ Atmos. Proc | Map Reading | Quant. Reas. | Total Points |
| Poss. Pts. | 24 | 15 | 28 | 25 | 11.5 | 7 | 134.5 |
| Mean score | 20.2 | 13 | 21.9 | 21.4 | 9.7 | 4.7 | 111.1 |
| % Score | 84.2% | 86.7% | 78.2% | 85.6% | 84.3% | 67.1% | 82.6% |

Below are comments and plans for individual assessment areas.

* Plate tectonics and structure:
	+ Comments: Students performed well overall in this area. The questions addressed problems and content that the students are introduced to in 100-level classes and focus on in upper-level courses
	+ Plan: We may consider adding or modifying questions to create a scaffold- structure with a varied complexity of questions to better assess depth as well as breadth of understanding.
* Solid earth composition:
	+ Comments: The questions in this area were mostly rock and mineral identification at a very basic level. Students performed well. There were fewer questions in this content area compared with others.
	+ Plan: We may consider adding questions to create a scaffold- structure with a varied complexity of questions to better assess depth as well as breadth of understanding.
* Surface and atmospheric processes
	+ Comments: The questions in this area were at a very basic level. Students performed well. Our curriculum has no required courses that focus on this content area. All of the seniors had at least one elective course in this area.
	+ Plan: We may consider adding questions to create a scaffold- structure with a varied complexity of questions to better assess depth as well as breadth of understanding.
* Earth history
	+ Comments: The questions in this area included more multiple-choice and fill-in than other parts of the exam and students performed at a slightly lower level than in other content areas. Two students commented that it had been a long time since they had taken any courses that covered some of the questions in this section.
	+ Plan:
* Quantitative reasoning
	+ Comments: The questions were very basic and include skills that are covered at least briefly in several upper level classes. Overall, there were too few questions in this area for a reasonable assessment. One student did not attempt several questions. Two students scored below 60%; the others scored above 70%.
	+ Plan: Faculty will develop a couple of basic problem sets that students will complete at the beginning of several upper-level lab courses to pre-assess their quantitative reasoning skills. Faculty will work with individual students and modify specific lab assignments to address areas of weakness. The courses that will use the new problem-set assessment tools include: Structural Geology (Geo 201); Groundwater (Geo 202); Geomorphology (Geo 208); and Environmental and Engineering Geology (Geo 216). Geo 201 is required by all majors but most majors take at least one of the other upper level courses as electives.
* Map reading skills
	+ Comments: The questions were very basic, but, overall, there were too few questions in this area for a reasonable assessment. Three students scored over 90% and one student scored below 60%.
	+ Plan: Faculty will develop a couple of basic problem sets that students will complete at the end of the introduction to map lab in Geology 101 and at the beginning of several upper-level lab courses to pre-assess their quantitative reasoning skills. In upper level courses faculty will work with individual students and modify specific lab assignments to address areas of weakness. The courses that will use the new problem-set assessment tools include: Introductory Geology (Geo 101); Geography and GIS (Geo 111); Structural Geology (Geo 201); Geomorphology (Geo 208); and Environmental and Engineering Geology (Geo 216). Geo 101 and 201 are required by all majors but most majors take at least one of the other courses as electives.

**Summary plan for next year’s exam:**

1. We will use most of the same questions from the content areas of the exam.
2. We will drop the skill-based questions from the senior exam and assess these skills in individual classes as described above.
3. We will modify a few of the content-area questions on the exam that were confusing.
4. We add questions to have approximately equal number of questions/points in different content area.
5. We will also add questions to give the exam more of a scaffold-structure, to assess varying degrees of breadth and depth of understanding.