General Education Assessment
Natural Sciences
2013-14

The University at Albany, SUNY

Assessment Report

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Institutional Research, Planning & Effectiveness

November, 2014
Categories Assessed: Natural Sciences, U.S. History, Foreign Languages

Background

In Spring 2013 the University at Albany assessed the degree to which students were achieving student learning objectives in Natural Sciences, U.S. History, Foreign Languages. As with previous assessments the sample was chosen to be generally representative of the categories rather than fully random. The Natural Sciences sample consisted of 12 classes from 8 different departments, with student N=1310 (45.5% of the Natural Sciences population). Enrollments in these courses ranged from 18 to 258. 11 of the 12 courses sampled were within the College of Arts and Sciences, one course from the School of Public Health was sampled.

Of the 12 classes sampled, 5 instructors submitted correctly completed forms\(^1\) at the end of the semester. Four instructors submitted partial data or forms that were either incomplete or filled out in a manner that precluded their use. One instructor did not participate. Data collected represents N=1002, which is 75% of the sample, and 34% of the population. This is a larger N but similar percentage of the population of students taking courses meeting this General Education requirement as the assessment of the Natural Sciences General Education requirement completed in the spring of 2011\(^2\).

The instructor participation rate on this administration of the General Education assessment was better in all three of the categories assessed than it has historically been. We believe this is attributable to 2 factors: 1) Better communication from IRPE, including earlier notification of selection for the sample, and a pre-notification of all instructors in the two categories by the Vice Provost for Undergraduate Education and the Associate Dean for General Education; and 2) regular and repeated communication from the Dean’s Office in the College of Arts and Sciences to instructors who were selected to be part of the sample. Instructors mapped their courses to specific learning objectives, reflected on assessment results, and discussed how their findings would influence their course design and pedagogy for these courses in future semesters. This is exactly what we hoped the assessment process would produce. Appendix B illustrates these activities and reflections.

Course Embedded Assessment

Eleven of 12 instructors sampled responded, though five provided data that was either incomplete or was not useable\(^3\). Total enrollment in courses meeting this General Education category was 2875 students. The sample consisted of 1,335 students, and the number of students assessed was 1002 (75% of sample, 34% of the population).

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\(^1\) Two instructors submitted grade distributions, not actual assessment results, but their submissions were otherwise complete. They are counted amongst the instructors who submitted otherwise incomplete data.

\(^2\) The 2011 assessment sample consisted of 1,964 students, and the number of students assessed was 1,028—which was 52.3% of the sample and 21.7% of the population.

\(^3\) In some cases, instructors simply submitted a syllabus and a few ancillary documents—and nothing regarding assessment.
Natural Sciences assessment results indicate that the majority of students “Exceeded” or “Met” expectations. As shown in the composite graph below, as well as graphs for each of the individual learning objectives on the following pages. Large majorities of students were reported to have either met or exceeded each of the four learning objectives, with the combined “Exceeded” and “Met” values being 66-67% for all four objectives.

![Natural Sciences: 2013-14 Academic Year](image)

**Figure 1: Summary of Natural Sciences General Education results.**

The Learning Objectives for the category are as follows:

Natural Sciences courses enable students to demonstrate:

1. an understanding of the methods scientists use to explore natural phenomena, including observation, hypothesis development, measurement and data collection, experimentation, evaluation of evidence;
2. an understanding of the application of scientific data, concepts, and models in the natural sciences;
3. an understanding of the major principles and concepts that form the basis of the knowledge covered in the course and a command of the relevant terminology appropriate for basic discourse in the particular discipline or disciplines of the course;
4. that they have become more knowledgeable consumers of scientific information and are prepared to make informed decisions on contemporary issues involving scientific information acquired in the course.
1) Students will demonstrate an understanding of the methods scientists use to explore natural phenomena, including observation, hypothesis development, measurement and data collection, experimentation, evaluation of evidence.

Figure 2: Natural Sciences Learning Objective 1

2) Students will demonstrate an understanding of the application of scientific data, concepts, and models in the natural sciences.

Figure 3: Natural Sciences Learning Objective 2
Comparison to 2008 & 2011 results:

In comparison to the 2008 and 2011 assessments of this category, we see marked improvements in the number of students who exceeded expectations in 3 of the 4 categories when compared to the 2011, and a drop in all 4 categories when compared to 2008. When “Exceeded” and “Met” are combined, we see drops in all categories from 2011, and all but one category from 2008. We offer no speculation to explain this change, other than to point out that the General Education Assessment forms have been revised extensively since the 2011 assessment, and we have

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4 It is not our intent to imply that these results are somehow “bad” or that the students are underperforming relative to past assessments. On the contrary, fully 2/3 of the students assessed either “exceeded” or “met” expectations. We believe that the new forms may have led to more accurate data being submitted.
developed an FAQ and video to assist instructors in filling out the form. The current forms are also easier to understand and complete.

In comparing 2014 data to 2011 and 2008 data in each of the four Learning Objectives individually (figures 7-10 on the following pages), there are no discernible patterns among the results, other than to note that students generally did “better” in 2008 than in 2011 or 2014.
Figure 8: Learning Objective 2, 2014, 2011, 2008

2) Students will demonstrate an understanding of the application of scientific data, concepts, and models in the natural sciences.

Figure 9: Learning Objective 3, 2014, 2011, 2008

3) Students will demonstrate an understanding of the major principles and concepts that form the basis of the knowledge covered in the course and a command of the relevant terminology appropriate for the basic discourse in the particular discipline.

Figure 10: Learning Objective 4, 2013, 2009, 2006

4) Students will demonstrate that they have become more knowledgable consumers of scientific information and are prepared to make informed decisions on contemporary issues involving scientific information acquired in the course.
Inclusion of graduate students and contingent faculty

Since the Spring of 2009, we have made a concerted effort to include courses taught by graduate student instructors, contingent faculty (typically under the title of “Lecturer”), and professional staff teaching on a part time basis in the general education assessment sample. As shown in Figure 11, below, visiting assistant professors and contingent faculty in particular teach a large percentage of the introductory undergraduate courses that meet the General Education requirements in this category. 48% (13 of 27) of the courses meeting the Natural Sciences general education requirement in Spring, 2014 were taught by tenured or tenure track faculty. While this finding is not unexpected, it does serve to demonstrate why any valid assessment in this category would need to require participation from non-tenure-related faculty.

![Figure 11: All Spring 2014 Natural Sciences General Education courses by instructor rank](image)

**All Natural Science General Education Courses by Instructor Rank**

<table>
<thead>
<tr>
<th>Instructor Rank</th>
<th>Population</th>
<th>Sample</th>
<th>Participated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professor</td>
<td>7</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Assistant Professor</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Visiting</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Lecturer</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>TA/GA</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**Figure 11: All Spring 2014 Natural Sciences General Education courses by instructor rank**

Time required to complete assessment

The general education assessment forms that faculty are requested to complete record the length of time it took them to prepare data for and complete the beginning and end of semester assessment forms (see Figure 12 and Appendix C). The average for the required preparation of the data and the completion of the forms was 93 minutes at the beginning of the semester, and 154 minutes at the end of the semester. There were no outliers at the beginning of the semester. When the high and low outliers are removed from the end of semester results, the time taken to complete the forms at the end of the semester drops to 118 minutes.
Recommendations:

1) The 2011-12 Natural Sciences General Education assessment report noted that:

   “Recommendation 1: IRPE, in collaboration with the Associate Dean for General Education and the Deans of the Schools and Colleges, needs to work to improve the response rate from the faculty chosen to participate in the sample—particularly the faculty teaching large “lecture center” classes.”

This concern has been addressed since the 2011-12 report, and it is largely resolved. The Dean of Undergraduate Education and the outgoing Associate Dean for General Education were instrumental in reaching out to instructional staff and reminding them that participating in assessment is part of their contractual obligations. The incoming Associate Dean has a long history of being involved in General Education assessment (and assessment more broadly), and we expect this relationship to continue and hope that it will lead to continuous improvement in both the quality and quantity of assessment data available to us.

2) We have now completed three complete rounds of general education assessment in the natural sciences category. To date we have not had a participant in the assessment process from the Physics Department. While they have been selected in the sample and a few have submitted rudimentary documents, no one from that department has participated in an end of semester assessment nor provided us with data that could be used to generate this report or the report that is generated by the Council on Academic Assessment. To that end, we recommend an assessment of the Natural Sciences General Education category that includes a sample constituted solely of courses from the Physics
Department\textsuperscript{5}. Assessment of the courses meeting the General Education requirement are not only mandated by SUNY, but are part of the Middle States accreditation process. This assessment should be conducted as soon as possible—preferably in the 2015-16 academic year—as that would allow for one additional opportunity for assessment of this category (and participation from the Physics Department) prior to our next Middle States reaccreditation report in the 2019-20 academic year.

3) Graduate student/contingent faculty - With great thanks to the deans and department chairs we were able to secure the participation of graduate student instructors, contingent and part time faculty in assessments of student learning in General Education courses. IRPE must continue to work with the deans and chairs to make clear to graduate student instructors, contingent and part time faculty, that General Education Assessment is included as part of their contractual responsibilities, and if selected for the sample, they are expected to participate without additional remuneration.

\textsuperscript{5} Given the relatively small number of courses from the Physics Department that meet this requirement, it would perhaps make sense to “sample” the entire population of courses that meet the requirement, in the hopes of having a large enough N to generate meaningful results.
Appendix A: Student Learning Objectives – Natural Sciences

Natural Sciences courses enable students to demonstrate:

5. an understanding of the methods scientists use to explore natural phenomena, including observation, hypothesis development, measurement and data collection, experimentation, evaluation of evidence;
6. an understanding of the application of scientific data, concepts, and models in the natural sciences;
7. an understanding of the major principles and concepts that form the basis of the knowledge covered in the course and a command of the relevant terminology appropriate for basic discourse in the particular discipline or disciplines of the course;
8. that they have become more knowledgeable consumers of scientific information and are prepared to make informed decisions on contemporary issues involving scientific information acquired in the course.
<table>
<thead>
<tr>
<th>Respondent #</th>
<th>Learning Objective #</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>1</td>
<td>While experimental design, and interpretation of experimental results are presented in [redacted], these are generally stressed more in the first half, which I do not teach. However, I do present certain critical experiments and their results. At the introductory level, our class examinations are generally centered around assessing whether or not students have assimilated enough general of the general principles of Biology to be able to dig deeper in the upper level courses. It is hard to balance presenting a lot of general principles and concepts and understanding the intellectual basis of our knowledge. Never the less I do as some questions requiring students to interpret experimental results or understand experimental design. Not surprisingly, this is an area where students struggle. Generally about half the class was able to develop a firm grip on these methods. Experience tells me that scientific education is a process and that this percentage will increase steadily over the next three years of their education.</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>When analyzing the relevant questions on my two (of four) exams, it seems that this is an advanced skill that is only beginning to emerge in the relatively inexperienced underclassmen. The design of (redacted) has traditionally been to introduce the student to important content at the risk of sacrificing instruction in the application of data. We try to start students to realize the applications and limitations of data, concepts in the natural sciences. The number of questions used to test applications is necessarily small because of the enormous amount of content that we cover. There is little time to go over all of the intracacies of how we know what we know and what exactly does it all mean.</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
<td>This is the heart of the matter in this general survey course. As the second part of a two course survey sequence, (redacted) completes the presentation of a freaking ton and a half of general biological content at levels of biological concentration from the atomic through the biosphere. It is a daunting task for instructors and students alike. As a “checkpoint” course, students are required to demonstrate their understanding and, to a lesser degree, their integration of this freaking ton and a half of content. Those who earn a satisfactory grade of C or higher, are considered ready to begin upper level coursework in the Biology Degree. Here, I think it is valid to use the suggested grade scheme for the four assessment categories. The numbers in this part reflect the final grades and thus the mastery of the presented content.</td>
</tr>
<tr>
<td>12</td>
<td>4</td>
<td>Other than teaching the students about biological and scientific principles, we do not stress &quot;consumer&quot; education at all. The goal of this course as designed by the Biology Department is to instill in the students the necessary background to be able to understand the material and concepts that will be presented in their upper level majors courses. Science is an intellectual process that attempts to determine truths based upon what is already established and known. In that respect any and all content helps students to make informed decisions about new claims and developments in the field in that these must be consistent with what is already known or must conclusively correct previously misunderstood concepts. While I</td>
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do talk about this in my lectures, I do not examine them on it.

Based on sample of five multiple choice questions outcome was 18/30/5/2, (all five correct/3 or 4 correct/2 correct/1 or 0 correct). Each question had five options so random chance is one correct. As usual with homework, some students did not submit carbon footprint assignment (late assignments were not accepted) resulting in the outcomes listed Please note that grade equivalent to C- (which is unsatisfactory U) is included as "approached" rather than "met" in this reported outcome due to categorization of multiple choice test result. The learning objective is the least explicitly emphasized objective in the course material. Carbon footprint assignment is an important hands-on exercise. No changes expected to be made for next time.

For test multiple choice sample outcome was 14/28/7/6. Similar note as in L.O. #1 concerning Assignment #1 In class examples and then practice with homework important to meeting this objective. Difficulty is assessing outcome specific to this objective is that a few students simply won't do the homework and many students, preferring to focus efforts on other parts on the exam, don't commit the time to doing the quantitative questions for that are part of the assessment of this L.O. on exams. Since this course is also required for environmental science majors, the objective includes a quantitative as well as qualitative understanding. That aspect of the objective is not attained by some non-science majors.

For test multiple choice sample outcome was 23/31/1/0. Essay outcome was a class aggregate and was not related to individual students. Reported outcome is average of essay outcome count with multiple choice test outcome result rather than individual student outcomes (but that is likely to be very similar) An important strategy is use of clickers to assess prior knowledge or misconceptions to pinpoint emphasis for discussion and then follow-up questions for identifying concepts or terminology that needs further clarification and discussion. No significant changes anticipated. I may more frequently show class responses while voting is in progress to assist in initiating move active classroom discussion.

For test multiple choice sample outcome was 29/28/3/1. Similar note as in L.O. #1 concerning Assignment 4 and out-of-class Writing this L.O. is the primary take away learning objective of the course. Including local and current issues (that are of course absent in the textbook) in the context of the global and national framework (text book material) is important for demonstrating relevancy..

Students seem to appreciate posting of powerpoint slides in Blackboard. The fact that the powerpoints are largely graphical (text is sparse) and clickers use contributes to grades keeps attendance good. Thinking maybe augmenting the currently individualistic writing assignment with a required class chat room to discuss among themselves some of the media reports students have written on.

As always, there is a great divide in math preparation. The students with solid preparation in pre-calculus-level math can do well in the course with hard work. Those without it can not make up for years of poor math preparation with hard work in (redacted).

I have attached the spreadsheet of final grade distributions to answer the "exceeded, met, approached, did-not-meet" portion of
| 20 | 1 | (1) Frequent use of clicker questions to assess students’ understanding of concepts. 115 questions were used during the semester.  
(2) Students would be provided with the opportunity to visit the University’s telescope in order to enhance their appreciation for the course topics. Clicker component of the course would count more than 5% toward the semester-grade. 5% was not sufficient incentive for some students to take the homework assignments seriously. |
| 20 | 2 | (1) Regular news updates from NASA that were explicitly related to course topics were described in 1-2 classes per week for the first 10-15 minutes; Class discussion on implications of those latest published data were commonly mentioned by students (e.g., in ITLAL mid-semester survey) as being interesting and important.  
(2) Students would be given 2 weeks, instead of 1 week, to complete the Capstone Project so that it could be scored with an even higher level of rigor. |
| 20 | 3 | (1) Regular news updates from NASA explicitly related to course topics;  
(2) Pre- and post-assessment instrument (developed in collaboration with NASA-funded educational assessment subcontractor) would count toward the clicker score at end of semester in order for students to take the pre- and post-assessment instrument more seriously. Since it did not count toward the semester-grade, some students tended to devote little effort to it, which diminished the value of the assessment. |
| 20 | 4 | (1) As an overall characteristic of the course, I was genuinely excited about the topics, and was never shy about showing that enthusiasm. That was noted and appreciated by students, as frequently mentioned in the mid-semester ITLAL survey.  
(2) Remarkably these Honors College students were reluctant to take notes during the class! Astonishing! Although I politely mentioned to the class that it was important to record what was being discussed in the class, it took disappointing scores on the first two exams before most students finally took notes. Until that point, most were content to *watch* and participate, but not to record. Astonishing! Perhaps my joy in teaching the course was distracting?? I just don't know! |
| 21 | 1 | Discussion of specific research papers gave insight and understanding of specific methods; in-class discussion and interactive discussion of controls and confounds is also vital. I’d likely add a small-group activity to confirm understanding of the genetic advanced methods. |
| 21 | 2 | This is the core of the class; it would not have been unreasonable to use the overall grades for this. Currently satisfied with basic structure; updating as new information is discovered. |
| 21 | 3 | It would be ideal to have additional TA-assisted input and editing of written assignments, perhaps; but basically happy with students’ general performance on this metric; correlated strongly with effort as far as I could tell. |
| 21 | 4 | Lots of current examples from current events, pop culture, and disease states including soliciting input and feedback on e.g. family members. My sense is that we have as much of this as is possible. Students failing to meet expectations are generally failing to grasp information accurately, not failing to see how they might apply it. |
Appendix C: Time to Completion and Comments

<table>
<thead>
<tr>
<th>Respondent #</th>
<th>Time Complete Form 1 (in minutes)</th>
<th>Time to Complete Form 2 (in minutes)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>60</td>
<td>20</td>
<td>It is a challenge to teach general education courses, especially at the freshman level. That challenge is even greater in a large lecture setting. One can't help but wonder if lecture classes of 400 - 500 students are the most efficient method of &quot;general education.&quot; I know that I wonder about this. I actually think there is actually a better way, and that would be to have gen-ed classes limited to a size that would enable written assignments, essay exam questions, and oral discourse during class. That would require many more faculty and TAs then are currently in the available &quot;labor pool,&quot; but it just might be worth considering increasing the numbers of both teaching faculty and teaching assistantships to allow us to offer smaller gen-ed classes. I believe that currently a large percentage of our students is not ready to take full advantage of large lecture classes, and that this is especially true in the freshman year. I also believe that, as a required majors course, (redacted) might not be well suited for &quot;general education course&quot; status. For several years, I taught a non-majors course (redacted), that I personally feel was better suited for that designation. I was not totally pleased that we stopped offering that course and I think it would be a good ideal to reactivate it to better serve our gen-ed program.</td>
</tr>
<tr>
<td>13</td>
<td>20</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>120</td>
<td>480</td>
<td>I find it not easy to pigeon hole exam questions into the specific learning objects and don't want to design exam questions solely for that purpose (with 4 L.O. and four outcome categories that means devoting 16 questions just for a very statistically weak measure). After deciding on assessment tools, still took some time to go through data and collate by student (especially when exams have different versions) to determine outcomes for each L.O. Five of the questions used in this outcome assessment were also used for a pre-test Exam 1 #1 (pre-test #2) L.O. #1, #29 (pre-test #9) L.O. #2 Exam 2 #27 (pre-test #3) L.O. #3 Exam 3 #1 (pre-test #1) L.O. #3, #30 (pre-test #10) L.O. #4</td>
</tr>
</tbody>
</table>
| 15           | 120                              |                                     | I believe, especially for Physics courses, that some of these categories are extremely inter-related. For instance, it is difficult to assess or at least isolate student understanding of methods without simultaneously assessing their understanding of the concepts and principles. With my course, 'essay exams' is taken to mean exams (which include scientific problems as opposed to written essay problems) and 'multiple choice tests' is taken to mean multiple-choice problems included on the
| 16 | 120 | 10 |
| 17 |     |    |
| 18 | 120 | 60 |
| 19 |     |    |
| 20 |     | 90 |

As noted in my e-mail to Jeanette Altarriba on Tuesday, 3 December 2013, I was puzzled/disappointed that the phrase "employment of mathematical analysis" did not occur within any of the 4 learning objectives. I believe that that phrase occurs in the Definition of General Education Guidelines for Natural Science courses. That is a component that I have purposefully included in all of my Natural Science GenEd courses because I know it to be important in modern science. However, I know of other GenEd Natural Science courses (e.g., ATM and PHY) where instructors systematically omit any sort of mathematical analysis in order to get large enrollments and inflated SIRF scores. Those pseudo-science courses devolve merely into memorizing vocabulary and disconnected facts (i.e., little-if-any understanding of science; little-to-no addressing of the four learning goals involved in this survey). Formative assessments are conducted in my courses through ITLAL's mid-semester survey, which is significantly more rigorous and informative than the end-of-semester, summative survey (i.e., SIRF). In addition, the first- and last-day assessment instrument (accompanies this document as a separate attachment) that was developed in consultation with a subcontractor on my NASA grant has also been informative for evaluating the students' attainment. Finally, a subset of the ~130 in-class clicker-questions provide me with formative assessments of students' growth in understanding of the key disciplinary concepts and knowledge.

| 21 | 120 |

The space limits are very tricky, not permitting comprehensive answers in many cases. More generally, the objectives overlap to a large extent, so that separating their analysis and achievement is difficult and perhaps impossible: it will be the cases for most tools that mastery of ALL objectives is required for successful completion.