An Assessment of Student Comprehension of the "Big Ideas" in Biology in the Context of General Education Courses[1]

Joelle C. Presson[1], Kathy McAdams[2], Pam Lanford[3], Therese Leslie[4], Dave Straney[5], Edgar Moctezuma[5], Janet Coffey[6] University of Maryland, College Park, MD

Abstract

This project involves the assessment of student comprehension of the "Big Ideas" in biology in a general education context, at the University of Maryland College Park. Assessment of general education at UMCP is governed by the learning goals set by faculty groups working at different levels of abstraction. First, faculty from departments across campus set learning goals that apply across general education categories. Next, science faculty established learning goals for the science general education category. Finally, faculty in the life sciences determined how the science learning goals should be assessed. This group developed an assessment of student comprehension of the "Big Ideas" in Biology, using a reading comprehension and writing format. Student comprehension will be assessed before and after taking a general education life sciences course. Pilot data indicate that this assessment approach can provide meaningful results, but that incentives for student participation are needed. The assessment will be completed fall 2007 and the results reported at the January CABII meeting.

Introduction

As at many other institutions of higher education across the U.S., the University of Maryland College Park has embraced assessment, both out of necessity from an accreditation perspective and because assessment will improve teaching and learning at UMCP. Assessment is happening at all curricular levels, in all degree and certificate granting programs. The guiding principle at UMCP is that assessments must be faculty-driven, and they must be meaningful to the faculty who design, oversee, and teach the various academic curricula. For example, in the College of Chemical and Life Sciences, the faculty first are assessing content knowledge in lower level courses, and quantitative skills at all levels. Critical thinking and research skills will be assessed in later years.

The assessment of general education learning goals is more problematic, for several reasons. The learning goals in general education are by nature more global and less tied to specific courses or sequences of courses than is true in major's curricula. In addition, the courses in general education categories often cut across departments and colleges, making cooperative faculty-driven assessments more cumbersome. A group of UMCP faculty and administrators spent a year thinking and talking about the problem, and came up with a general education assessment procedure that is consistent with our guiding assessment principles.

General education at UMP is currently organized into content areas, and so the assessment of general education is organized around the required disciplines. Students are required to take courses from a designated list in the areas of Humanities, Social Science and Social History, Math and Science, and Cultural Diversity. Each year the campus will assess one of these general education areas.

---

[1] College of Chemical and Life Sciences, [2]Division of Undergraduate Studies, [3]Department of Biology, [4]Department of Biology, [5]Department of Cell Biology and Molecular Genetics, [6]Department of Curriculum and Instruction.

To give the assessments context and to integrate the learning goals across the general education program, the first step was for learning goals to be set for the entire general education curriculum. Faculty groups met, discussed, and finalized these goals.

I. Overall general education learning goals

1. Demonstrate understanding of major findings and ideas in a variety of disciplines beyond the major;
2. Demonstrate understanding of methods, skills, tools and systems used in a variety of disciplines, and historical, theoretical, scientific, technological, philosophical, and ethical bases in a variety of disciplines;
3. Use appropriate technologies to conduct research on and communicate about topics and questions and to access, evaluate and manage information to prepare and present their work effectively to meet academic, personal, and professional needs;
4. Demonstrate critical analysis of arguments and evaluation of an argument's major assertions, its background assumptions, the evidence used to support its assertions, and its explanatory utility;
5. Understand and articulate the importance and influence of diversity within and among cultures and societies;
6. Understand and apply mathematical concepts and models; and
7. Communicate effectively, through written and oral communication and through other forms as appropriate.

Next faculty from the various science disciplines discussed and finalized the learning goals for the science general education category. These clearly build on the learning goals for the general education program overall.

1. Use quantitative information and/or mathematical analysis to obtain sound results and recognize questionable assumptions;
2. Demonstrate understanding of the broad principles of science and the ways scientists in a particular discipline conduct research;
3. Make observations, understand the fundamental elements of experiment design, generate and analyze data using appropriate quantitative tools, use abstract reasoning to interpret the data and formulae, and test hypotheses with scientific rigor;
4. Understand how findings and ideas in science can be applied to explain phenomena and events and influence the larger society;
5. Understand the role that human diversity plays in the practice and history of science;
6. Communicate about science using appropriate oral and written means; and
7. Demonstrate proficiency in the collection, interpretation, and presentation of scientific data.

The execution of assessment of these learning goals was also placed in the hands of faculty groups. The general model adopted parallels the approach being used to assess learning goals in the majors and certificate programs. Faculty who teach in the various general education disciplines are charged with designing and evaluating the assessments. Institutional support is provided to carryout the assessment. The faculty groups in each area are supported and guided by administrators familiar with assessment practices. One major guideline is that any given assessment project will be small in scope, much like any given scientific study is small in scope

in order to obtain clear answers. Within this context a group of eight faculty, the authors of this paper, designed a specific assessment for the life sciences general education curriculum.

Methods

Despite the long list of learning goals, the major focus of most science general education courses is on science content. Not surprisingly, the faculty charged with designing the assessment in the area of life sciences general education gravitated toward assessment of mastery of content. This relates to learning goal #1 in the overall area and learning goal #4 in the physical and life sciences area. Discussion amongst this group of faculty quickly focused on the ability of students to recognize the "big ideas" in biology, to write about them in an articulate way, and to see their expression in popular scientific journalism.

The "big ides" in biology that this working group came up with and the instrument for assessing student understanding can best be described by simply sharing the instructions given to students. The articles referred to in these instructions were one-page summaries of a scientific paper obtained from a poplar science news publication, such as *Science News*. All of the students in one course read and responded to the same article.

Read and React: A CORE Science Exercise

1. Read the attached article.

2. Consider the following list of core concepts in science, and circle three of these concepts that are represented in the article.

Concept List

a. Knowledge about life is derived from the process of science.
b. Life emerges from chemistry.
c. Life is cellular.
d. Life forms adapt and evolve.
e. DNA directs development.
f. DNA is the basis for inheritance.
g. DNA is the basis for biological diversity.
h. DNA is responsible for unity and diversity of life.
i. There is an interaction between biology, culture, and environment.
j. Life requires energy.

3. Choose one concept you have circled. Write one paragraph in which you (a) fully explain the concept as you understand it, and (b) tell how this concept relates to the article. Be sure to cite specific examples of information in the article that relate to the concept you are writing about. Please write your reaction legibly on the back of this page.

4. Read over the paragraph you have written to be sure that you have mentioned specifics about the article for each of your selected concepts. Also check for clarity and accuracy in your writing.

5. Please provide the following information to help with data analysis. (All of your answers will be confidential, and results of this exercise will only be reported as aggregate data from large groups.)

a. Your major:_____
   Please indicate whether this is your intended major ____ or your declared major ____.
b. The number of college credits you had at the beginning of this semester:___
c. Other science courses you have taken at the University of Maryland:

_____

d. AP or undergraduate science courses you have taken at other schools:

---

e. Gender: female _____ male _____

Thank you for completing this exercise.

The assessment was designed to be done at the beginning of a life sciences general education course and at the end, to determine if taking the course had any impact on student understanding of these important concepts. Four general education life sciences courses were chosen as the targets for assessment:

ANTH220 Introduction to Biological Anthropology, a major's course also taken by many non-majors;
BSCI103 World of Biology, a strictly non-major's course;
BSCI105 Principle of Biology I, a major's course also taken by many non-majors;
BSCI124 Plant Biology, a strictly non-major's course.

In the original design it was intended to do the post-course assessment spring 2007 and do the pre-course assessment on a different group of students fall 2007. The spring 2007 assessment was carried out on the day of course evaluations in three of the courses, and on the day of the final in one course. Students were not given extra credit points for doing the assessment in three of the courses, and were given extra credit points in one course. Trained graduate students, using the rubric below, scored the writings. During the first grading session the graduate student graders discussed and modified the rubric until the category definitions were clear and they felt they could objectively apply the scoring criteria.

Rubric

	0 **Inadequate comprehension**	**1** **Some comprehension**	**2** **Basic comprehension**	**3** **Good comprehension**
Ability to identify three relevant concepts	Student did not circle any relevant concept.	Student circled one relevant concept.	Student circled two relevant concepts.	Student circled three relevant concepts.
Ability to explain one key concept	Student did not explain the concept.	Student response contains elements of an accurate explanation of concept.	Student adequately explained concept.	Student fully explained the concept and included elaboration.
Ability to apply understanding of one key concept	Student made no relevant connections to the article.	The student made one or more connections to the article, but attempts at meaningful connections are inadequate.	The student began to discuss the concept in the context of the article, and included some supporting details.	The student response demonstrated sophisticated use of concept in the context of the article, including supporting details.

Ability to communicate understanding of one key concept using good English skills.	The student response was inarticulate.	The student response is not clear and contains many grammatical errors.	The student response is mostly clear and straightforward and contains some grammatical errors.	The student response is clear and straightforward and contains only few grammatical errors.

The results for spring were fully analyzed, as discussed below. However, it seemed evident from the quality of answers that many students did not put effort into the assessment. For this reason the entire project is being re-done this fall. The same courses, articles, and instructions are being used as for the pilot in the spring. Three major changes are being made, however. First, nearly all students in the selected courses will be sampled by asking students to take the assessment in their laboratory sections. Second, the pre-course assessment will be carried out on half of the students in the first weeks of the semester, and the post-course assessment will be carried out in the last week of the semester. Third, the students in each course will be given a small number of extra credit points for completing the assessment. The writings from the pre-course and post-course will be coded with numbers corresponding to each, and scored using the same rubric and by the same trained graduate students who scored the pilot writing samples. In this way the scorers will be blind to whether a given paper is pre-course or post-course, and the two will be scored in the same way.

Preliminary Results

Pilot data from the end of spring 2007 life sciences general education courses were obtained from the responses of 480 students. Students had no difficulty in identifying the biology concepts reflected in the article they read. Eighty percent of respondents circled three concepts. In general the concepts circled were relevant to the article they read, and did not include less relevant ideas. For example, fewer than 10% of the concepts circles were “DNA is the basis for diversity” or “DNA is responsible for the unity of life”. This response rate is appropriate as none of the articles that the students read directly dealt with the unity and diversity of life.

The students wrote an average of 473 words in response to the queries asking to explain and apply the concepts, although some students wrote only a sentence or two. The distributions of the abilities of students to explain and apply the biology concepts are shown in Figures 1 and 2, respectively. Note that at the end of the general education life sciences course only about 20% of students had a good understanding of the concept and only about 10% could communicate how the concept was related to the topic of the article. Writing communication scored somewhat higher. In this assessment the graders tried to separate use of language and clear wording from the content of the article. In practice this was not always easy to but the higher scores shown in Figure 3 indicate that our students write at a higher level than they understand.

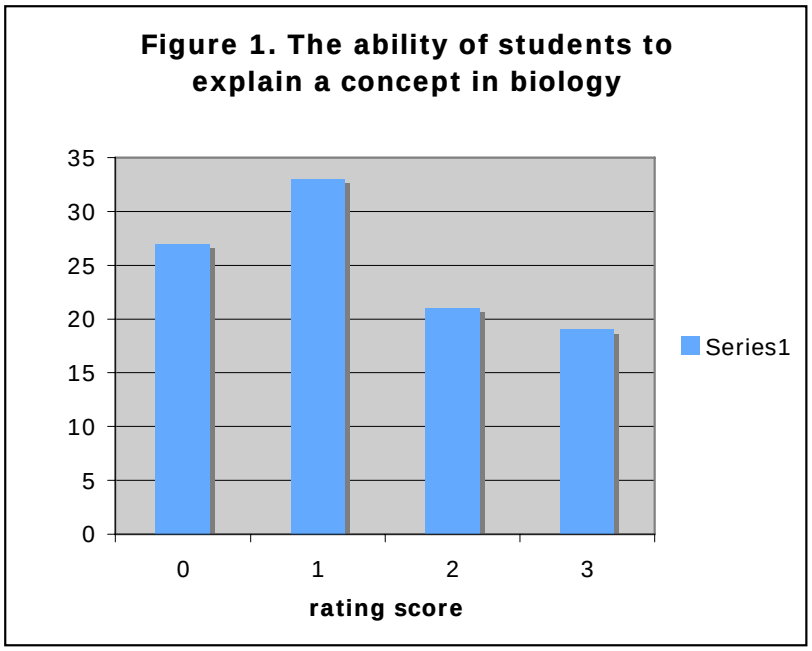


Figure 1. The ability of students to explain a concept in biology
35
30
25
20
15
10
5
0
0
1
2
3
rating score
Series1

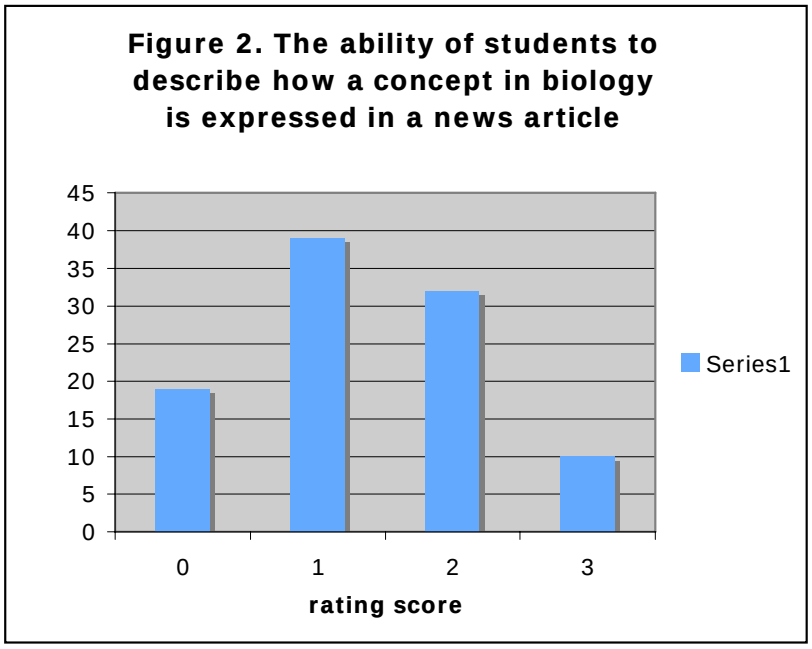
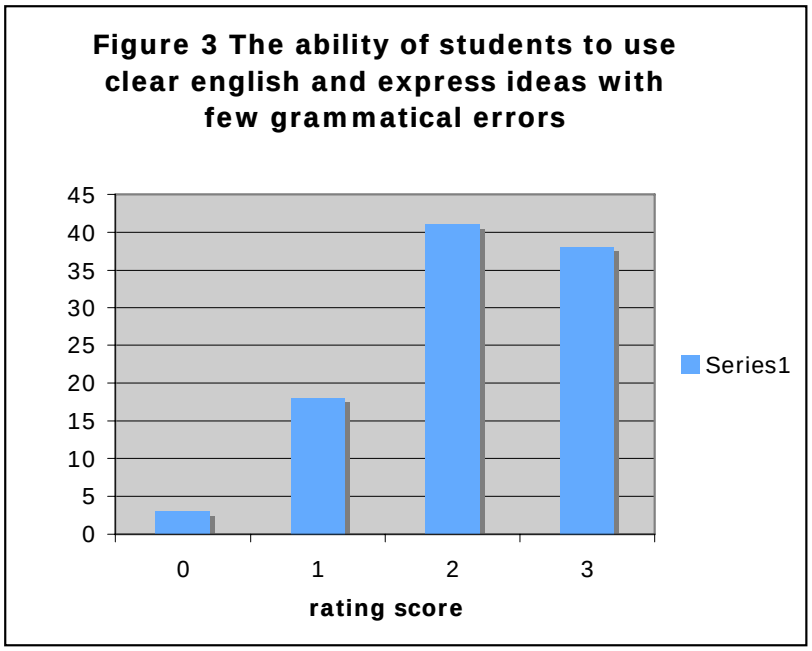


Figure 2. The ability of students to describe how a concept in biology is expressed in a news article
45
40
35
30
25
20
15
10
5
0
0
1
2
3
rating score
Series1



Discussion

One of the goals of any science general education curriculum is for students to understand, apply, and communicate the important conceptual ideas in the field. While it is difficult to say what the level of expectation should be regarding these abilities, the level of all three abilities in this pilot assessment are not where they should be. There are, however, some problems with this assessment that require a replication before the results are acted upon.

The assessments in three of the four courses were given on the day of course evaluations, and no points were given for participation. This presents two problems. First, many students do not attend the course evaluation and so this procedure does not sample all of the students. While it may not be necessary to sample all students, the assessment procedure we used is capable of handling all of the students registered in the four courses, and so it is desirable to do so if we can. Second, both the venue of the day of course evaluations and the lack of any points associated with the assessment undoubtedly reduced student motivation to take the assessment seriously and do their best. The six graduate student graders were in agreement that many of the papers seemed to reflect minimal effort. For these reasons the assessment is being completely redone this fall, as describe above. Results from this replication will be analyzed, and compared with the results from the spring 2007 pilot.