Report from the Science Committee on the Assessment of General Education

Four faculty members are each working on their own or with departmental partner(s) on the assessment of student learning goals in Science courses that can be used to satisfy the Science general education requirements. Four departments participated

Biology - Goodrich\*, Morris, Weaver

Computer Science –Fischbach\*\* and Kortsarts

Mathematics- Olanoff \*with DiScala and Y. Akl

Physics and Astronomy – Marshall\* and department members

A faculty representative\* from each department submitted a report. These reports are presented here.

**Dept. of Biology**

**General Education Assessment**

**A& S General Education Goal:**

4) A liberally educated graduate has developed a wide range of intellectual perspectives and methodologies.

a) Evaluates the workings of the natural and physical world using theories and models that can be tested by experiments and observations.

**Science General Education Goal for Biology 101**

Students understand the process of evolution by means of natural selection.

We settled on a 4 point scale with a 0-3 score,

The committee agreed that not all questions used for this assessment would apply to all 3 levels described above. A “2” might be the highest score possible for some questions, for example.

|  |  |  |
| --- | --- | --- |
| **Score** | **General Criteria** | **Specific Criteria for BIOL 101 question** |
| **3 Masterful** | Extend and apply model to a different situation or apply multiple models to solve a problem, get correct answer, and explain relationship | Demonstrates a clear articulate understanding of key concepts needed fully answers question correctly, may be able to tie key concept(s)to other key concept(s) |
| **2 Competent** | Clearly demonstrate that they know what model to use and how to solve the problem; explain a theory or model | Demonstrates adequate understanding of key concepts needed while addressing the question-answers question correctly |
| **1 Beginner** | Identify which theory or model is appropriate, not using misconceptions | Demonstrates basic understanding of key concepts needed to address question |
| **0 Not Adequate** |  | No understanding of concepts needed to address question to very little understanding |

**Assessment was performed using questions on student exams from 2 cohorts.**

**Exam Questions and Standards**

(15) Give a biological definition for evolution.

50% of students are expected to score 2 or higher

(16) Explain the process of natural selection. Important ideas you may want to use include carrying capacity, competition, genetic variation, and differential reproductive success.

50% of students are expected to score 1 or higher

(17) A woman with brown hair dyes her hair red. Can this woman “pass on” her red hair to her future children? Explain why or why not. (This question addresses the genetic basis of evolution)

50% of students are expected to score 1 or higher

BIOL 101 Fall 2011 Cohort

|  |  |  |
| --- | --- | --- |
| Question | Number reaching target score | % of class |
| 15 | 12/23 | 52% |
| 16 | 20/23 | 87% |
| 17 | 23/23 | 100% |

BIOL Fall 2012 Cohort (scored by 3 faculty)

|  |  |  |
| --- | --- | --- |
| Question | Number\* reaching target score | % of class |
| 15 | 4/14 | **28%** |
| 16 | 12/14 | 86% |
| 17 | 14/14 | 100% |

\*Average rounded to nearest whole number

Exams from Fall 2013 have not yet been assessed. We expect to do this in May or early June 2014

**Conclusions** – target exceeded in all but one case (see bold face above). A trend is beginning to emerge in question 15; one for which we had higher expectations than the other two.

**Future plans-** Complete the assessment of the Fall 2013 class. Consider using a pre-post assessment. Without a pre-test, it is very difficult to determine if that students in any particular academic year have pre-existing knowledge of the subject, or pre-existing misconceptions. Consider how to correlate the scores on the assessment rubric with students’ prior academic experience.

**Dept. of Computer Science**

**General Education Assessment**

**Goal**

Employs logical reasoning and problem-solving methodologies to construct algorithms.

(From Definition of a Science Course approved by Science Division in 2009.)

**Corresponding A&S Goal**

4) A liberally educated graduate has developed a wide range of intellectual perspectives and methodologies.

a) Evaluates the workings of the natural and physical world using theories and models that can be tested by experiments and observations.

**Course:** CSCI 152, 18 students

**Assessors:** Adam Fischbach and Yana Kortsarts

**Method:** Two exam questions that require students to devise the programming logic to solve a given problem.

**Target:** 65% of students are Competent or Masterful.

**Results Summary**

Problem 1: 12 of 18 students (67%) scored Competent or Masterful, meeting the target.

Problem 2: 8 of 18 students (44%) scored Competent or Masterful, not meeting the target.

Both questions were given on the same exam and comprised the entire exam. Problem 1 was worth 75% of the exam grade. The results from this question show that most students know how to devise the solution to a problem that is similar to one they have seen before. However, only two students were Masterful. For Problem 2, there were five students who did not attempt the problem at all. It is unknown whether these students failed to solve the problem because it was too difficult or because they spent all of their time on Problem 1.

We observed that very few students were able to devise original solutions. Since this was an open-notes exam, most students started with solutions to similar problems (or problems they thought were similar) and attempted to alter them to solve the given problems.

**Results**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | 3 - Masterful | 2 - Competent | 1 - Beginner | 0 – Not Adequate |
| Problem 1 | 2 | 10 | 4 | 2 |
| Problem 2 | 2 | 6 | 3 | 7 |

Computer Science Problem 1

|  |  |  |
| --- | --- | --- |
| **Score** | **General Criteria** | **Specific Criteria** |
| **3 Masterful** | Extend and apply model to a different situation or apply multiple models to solve a problem, get correct answer, and explain relationship. | Students correctly use loops, conditional statements and function calls. Program does not perform unnecessary tasks. Program computes correct solution. |
| **2 Competent** | Clearly demonstrate that they know what model to use and how to solve the problem; explain theory or model. | Students demonstrate that they know how to set up solution using loops, conditional statements and function calls.  Logic may not be completely correct. |
| **1 Beginner** | Identify which theory or model is appropriate, not using misconceptions. | Identify the need for loops and conditional statements. |
| **0 Not Adequate** |  | Students demonstrate no understanding of problem or how to construct a solution. |

**Problem 1:**

A website is publishing the following password rules:

1. length: at least 6 characters and no more than 10

2. the password must include at least ONE special character (a character that is not a letter and not a digit)

Write a function *def valid\_pswd(my\_str)* that has one parameter, a string of characters.

The function returns True, if *my\_str* is a valid password, and False otherwise.

Write a function *def valid\_list(my\_list)* which has one parameter, a list of strings.

The function creates and returns the list of valid passwords.

Use function *valid\_ pswd* to determine the validity of each string in the list.

If there are no valid passwords, the function returns an empty list.

Complete the main to find the list of valid passwords. Make sure you take care of the case of no valid passwords in the list

Computer Science Problem 2

|  |  |  |
| --- | --- | --- |
| **Score** | **General Criteria** | **Specific Criteria** |
| **3 Masterful** | Extend and apply model to a different situation or apply multiple models to solve a problem, get correct answer, and explain relationship. | Students correctly use single loop to traverse array, employ conditionals and summation logic to compute correct answer. |
| **2 Competent** | Clearly demonstrate that they know what model to use and how to solve the problem; explain theory or model. | Students demonstrate that they know how to set up solution using loop to traverse array, if-else to compare votes and summation to compute winner.  Students may use nested loop and logic may not be correct. |
| **1 Beginner** | Identify which theory or model is appropriate, not using misconceptions. | Identify the need for a loop, a conditional and summation. |
| **0 Not Adequate** |  | Students demonstrate no understanding of problem or how to construct a solution. |

**Problem 2:**

In the United States, the winner of a presidential election is the candidate with the greatest number of points. Each state in the nation is allocated a specific number of points. Let’s assume that the candidate who wins the most popular votes in a state is given *all* of that state’s points. For example, Pennsylvania has 20 points. So, the candidate who wins the popular vote in Pennsylvania gets all 20 points. Assume you have a two-dimensional array of integers named *votes* that contains a column for each state and 3 rows. The first row contains the number of popular votes Candidate A won in each state. The second row contains the number of popular votes Candidate B won in each state. The third row contains the number of points for each state. Write a function that determines which candidate won the election.

Example (assuming there are only seven states):

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 382 | 47 | 167 | 844 | 219 | 57 | 93 |
| 210 | 312 | 230 | 561 | 119 | 112 | 18 |
| 10 | 15 | 5 | 20 | 10 | 5 | 3 |

Votes for Candidate A

Votes for Candidate B

Points

For the state in the first column, Candidate A has 382 votes and Candidate B has 210 votes. So, Candidate A wins the state and gets 10 points. Candidate A wins the states in the first, fourth, fifth and seventh columns. So, Candidate A gets 10 + 20 + 10 + 3 = 43 points. Candidate B wins the states in the second, third and sixth columns and gets 15 + 5 + 5 = 25 points. Candidate A wins!

**Dept. of Physics and Astronomy**

**General Education Assessment**

**1. Goals**

Widener University's General Education Goals (2006) contains the following:

2. Students understand and use quantitative methods effectively

Additionally, the following are goals of the College of Arts and Sciences (2009):

3. Uses quantitative methods effectively.

3.1 Students will be able to use mathematical methods to solve problems

3.2 Students will be able to interpret, make inferences, and draw conclusions from data presented in tabular or graphical form.

3.3 Students will be able to determine if numerical results are reasonable.

5. Understands and applies methods of inquiry and explanation

5.1 Students will understand and apply scientific methods

The Department of Physics and Astronomy set out to assess these goals in PHYS 142, an introductory level course taken by biology and pre-physical therapy students.

**2. Assessment Criteria**

Students were placed into one of four categories based on their work.

* **Unsatisfactory** – does not show an awareness of physical law or theory necessary to solve the problem.
* **Beginner** – shows an awareness of the physical law or theory applicable, but unable to successfully apply it without significant errors or misunderstandings
* **Competent** – able to apply theory and find a solution to the problem, but with small conceptual or mathematical errors
* **Proficient** – able to apply theory and find a correct answer

**3. Outcome**

Students were evaluated on two questions from a PHYS 142 exam, where the focus was on electricity and magnetism.

In the first question, students were shown part of a circuit with two resistors. The students were given the current through one resistor, and asked to find the current through the other. They must recognize that the change in potential (*V*) is the same for both resistors, and then use Ohm's law (*V = IR*) to find the current. The second half of the question asks about the current at the top of the circuit, which is the sum of the currents in each of the branches below.

The second question asks about a proton that is being repelled by a small positively charged bead. The students must use conservation of energy to find the speed of the proton when it is infinitely far from the bead.

Our goals for this assessment were as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Evaluation | Question 1 |  | Question 2 |  |
| scale | Actual | Goal | Actual | Goal |
| **Beginner** | 82% | 90% | 86% | 90% |
| **Competent** | 60% | 60% | 39% | 40% |
| **Proficient** | 45% | 30% | 17% | 20% |

For question 1, we expected 90% of the students to show at least a beginner level of understanding, with the majority (60%) demonstrating competency, and 30% being proficient. The results show that while not everyone was able to achieve the beginner level, a larger than expected number were able to show proficiency.

Question 2 was a more difficult question, so the expected levels of competency and proficiency are lower than for question 1. While the outcome was slightly lower than our goal numbers, we do not feel that this represents cause for concern. With 65 students taking the exam, the percentage difference between our goal and the actual results represents 1-2 students.

**Dept. of Mathematics**

**General Education Assessment**

**Math 131 General Assessment Goals**

**Goal**: *Evaluates the workings of the natural and physical world using theories and models that can be tested by experiments and observations*.

**Possible Mathematics Sub-goal**: *Employs logical reasoning and problem-solving methodologies to construct algorithms and proofs*.

**Assessors**: Dana Olanoff, Elizabeth DiScala, Yasmine Akl

**Problems:**

Our plan is to use 2 or 3 questions from Math 131 Final Exam, which will be written in the near future by Elizabeth DiScala and Yasmine Akl:

Two possible questions from previous final exams are below. We will use these two questions or some that are similar, and try to add another question that will fit the goals outlined above.

Position, Velocity and Acceleration Question:

A dynamite blast blows a heavy rock straight up with a launch velocity of 160ft/sec. It

reaches a height of s=160t-16t2 after t sec.

a) Find the velocity equation.

b) How high does the rock go?

c) What is the velocity and speed of the rock when it is 256ft above the ground on the

way up, and on the way down?

d) What is the acceleration of the rock at any time t during its flight?

Graph Question:

Consider the function



a) Find the critical points of the function.

b) Find the local maxima and minima of the function.

c) Find the inflection points and concavity of the function.

d) Graph the function. Clearly label it.

**Scoring Rubric:**

We will use the general scoring rubric outlined below. Once we have written the questions, we will amend the rubric so that it is specific to each question.

1. Little to no understanding of key concept(s) needed to address question
2. Demonstrates a basic understanding of key concept(s) needed to address question
3. Demonstrates an adequate understanding of key concept(s) while addressing the question—answers the question correctly
4. Demonstrates a clear, articulate understanding of the key concept(s); fully answers question correctly; may tie key concept(s) to other key concept(s)

**Expected Outcomes:**

Once we have designed the specific questions, we will be able to give expected outcomes.

**Results: f**orthcoming

We will use the final exams from Spring 2014 semester, so we expect to have results by the middle of May, 2014.

**Comments**:

Forthcoming

**Overall conclusions from this set of reports:** General Education Goals for Science have been met or exceeded in the courses evaluated using this type of end point analysis.

One broad conclusion that we reached is that the Science General Education Goals are not easily interpretable by mathematics and the physical sciences. Faculty from these departments chose either to assess additional goals from A&S with or without statements from our definition of a science course.

**Future goals for the committee are:**

Recruit participants from the other departments in science

Suggest the use of pre-post testing as this has been effective in assessment within the curricula of science majors.

Suggest possible revisions to the science general education goals