Development of a Methodology to Investigate Consistency in Assessment of Learning Outcomes for Biology 121

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Biology 121:
Testing for Consistency Amongst Sections

Biology 121 introduces students to Ecology, Evolution, and Genetics. It is a require course in the Biology Program, and enrolls approximately 2200 students per year in 10 different sections.

Our goals were to test for consistency in assessment amongst the different sections of Biology 121, then to use our results to make recommendations to the course teaching team.

We asked four questions:

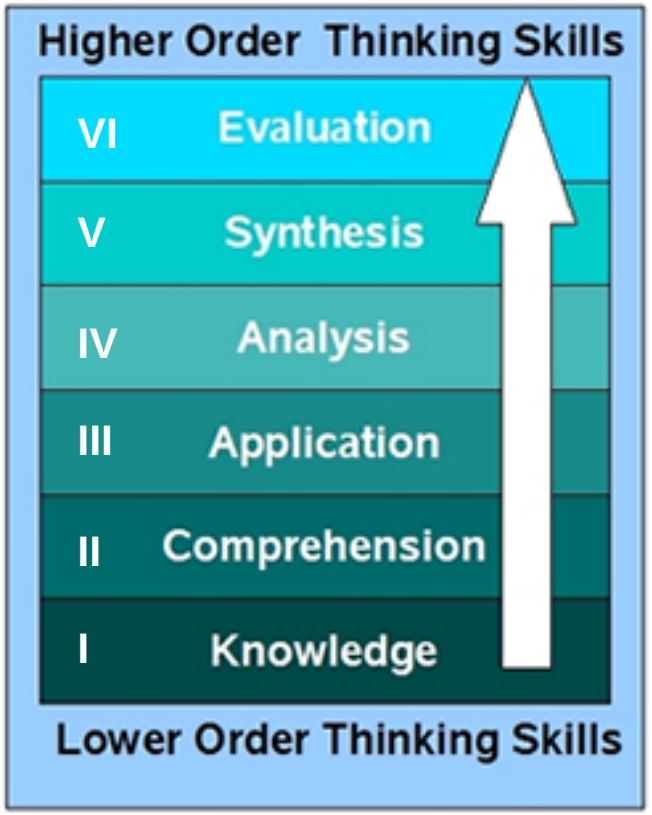
1. Are there differences overall in the Bloom's Level of exam questions in different sections?
2. Are there differences in the types of questions used on exams in different sections?
3. Are the course learning outcomes emphasized equally in all sections?
4. Is each of the course learning outcomes assessed at the same Bloom's Level as it is stated?

Biology 121:
Testing for Consistency Amongst Sections

1. Four Biology 121 instructors donated the midterm and final exams used in their section, as well as the course learning outcomes used by all sections (Jan-Apr 2008)

2. We categorized each exam question by question type, and also calculated the relative weight of each question for each exam in each section

3. We categorized each exam question for each section into one of the six Levels of Bloom's Taxonomy using the Blooming Biology Tool (Crowe *et al*. 2008) as a rubric, assessing both inter-rater (80%) and intra-rater (90%) reliability to ensure consistency



4. We determined the Bloom's Level Distribution for each section (the percentage of all available exam marks at each Bloom's Level), then compared between sections

Biology 121:
Testing for Consistency Amongst Sections

5. We determined the percentage of multiple choice and written answer questions at each Bloom's Level for each section
6. We mapped each exam question for each section to the appropriate course learning outcome(s)
7. We determined the percentage of all available exam marks for each section allotted to each course learning outcome, compared between sections, then used this information to recommend modifications for streamlining the course learning outcomes
8. For each section, we determined the average Bloom's Level at which each learning outcome was examined
9. Using the Blooming Biology Tool (Crowe *et al*. 2008), we determined the Bloom's Level of each of the course learning outcomes
10. For each section, we compared the stated Bloom's Level of each learning outcome to the average Bloom's Level at which it was examined, then used this information to recommend modifications to the Bloom's Level of the stated learning outcomes

Biology 121:
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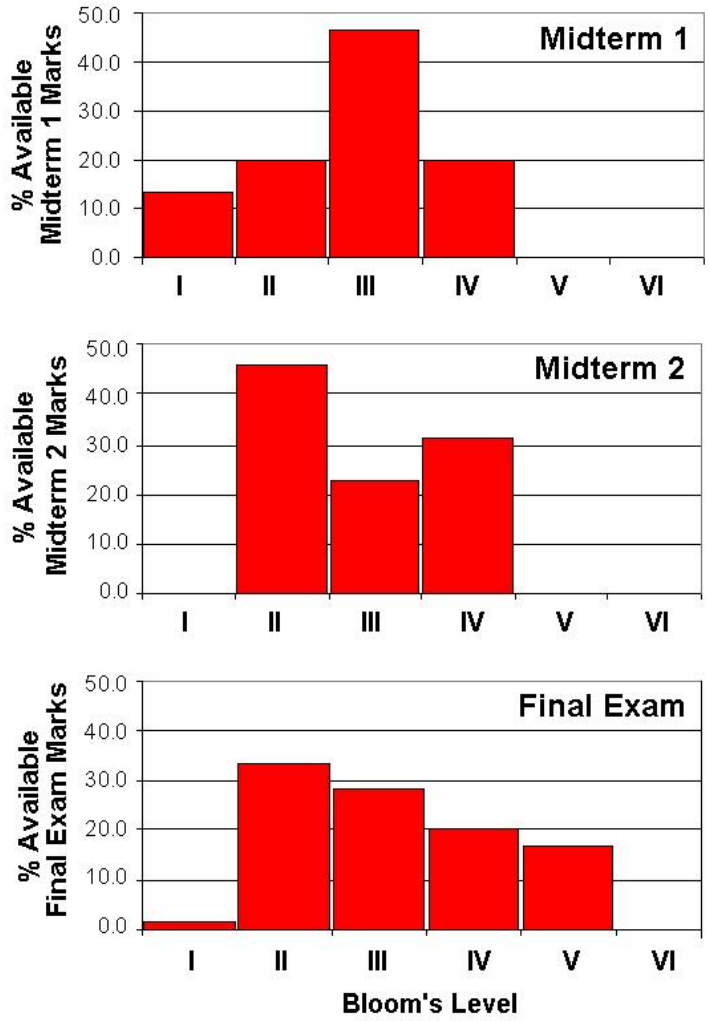

Figure 1: Percentage of Available Exam Marks at Each Bloom's Level: Progression from Midterms to Final Exam for a Representative Section of Biology 121 (Section A, Jan-Apr 2008)

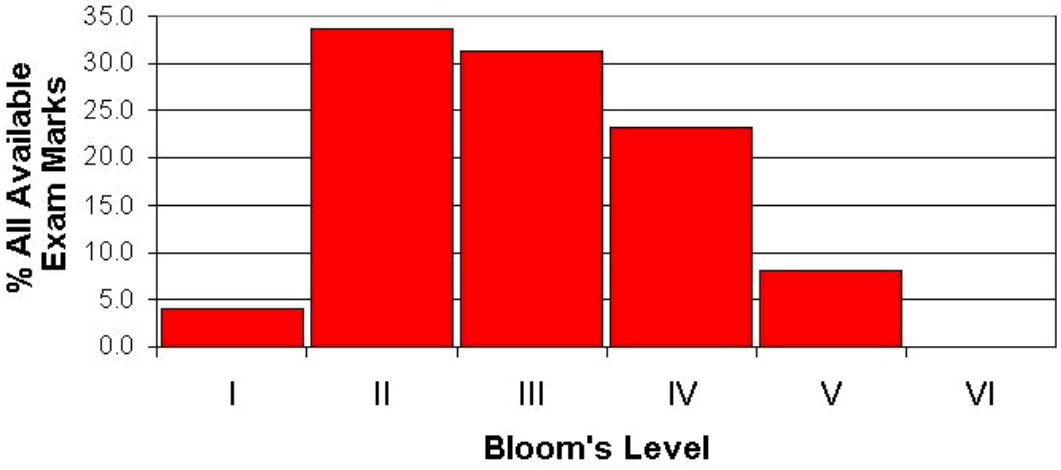

Figure 2: Bloom's Level Distribution for a Representative Section of Biology 121 - Percentage of All Available Exam Marks at Each Level of Bloom's Taxonomy (Section A, Jan-Apr 2008)

Bloom's Level Distribution of exam marks for a representative section, showing the progression from midterms to final exam (Figure 1) and the overall Bloom's Level Distribution for this section (Figure 2).

Biology 121:
Testing for Consistency Amongst Sections

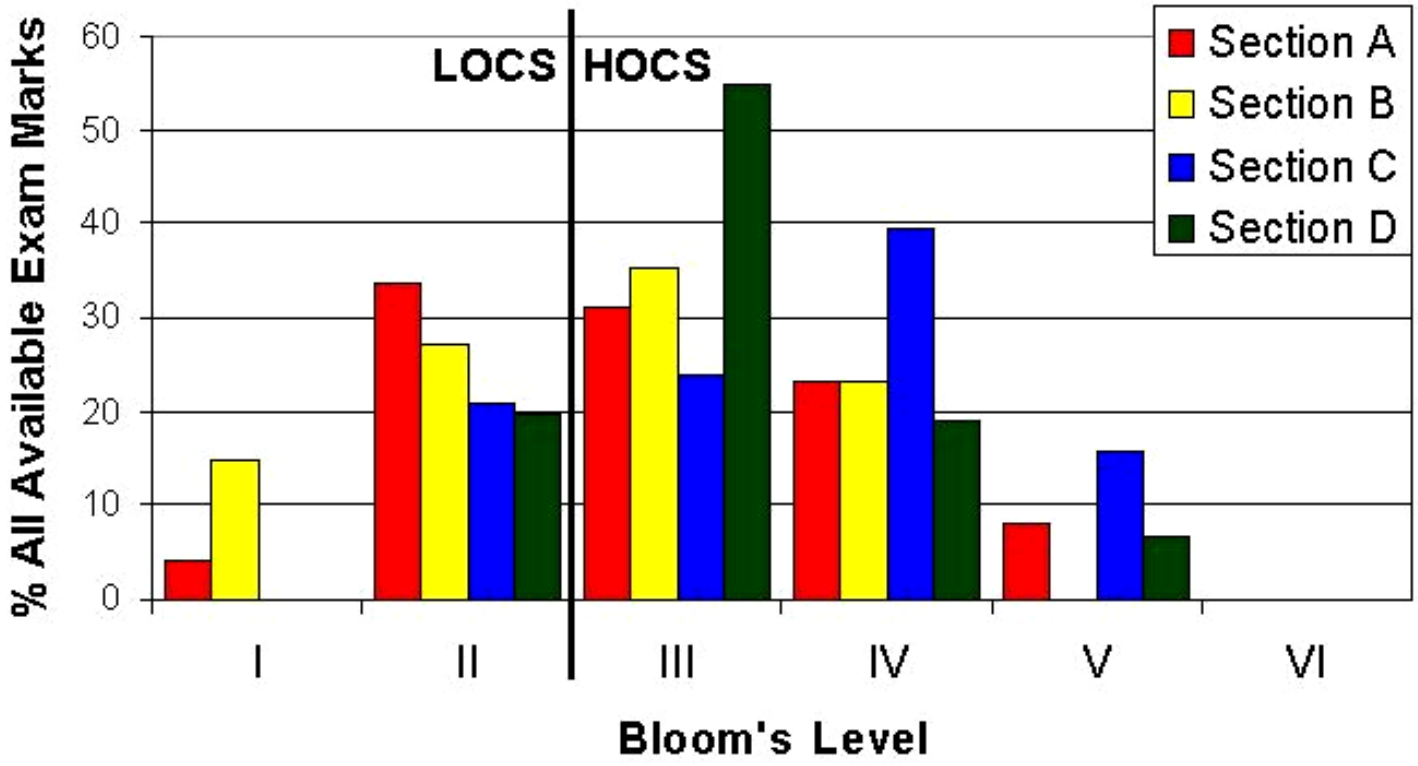

Figure 3: A Comparison of Bloom's Level Distribution amongst Four Sections of Biology 121 - The Percentage of All Available Exam Marks for Each Section at Each Level of Bloom's Taxonomy (Jan-Apr 2008)

Biology 121:
Testing for Consistency Amongst Sections

Differences in Exam Question Types

Section A:
37% Multiple Choice
63% Short Answer

Section B:
22% Multiple Choice
73% Short Answer
5% Paragraph

Section C:
35% Multiple Choice
44% Short Answer
21% Paragraph

Section D:
100% Short Answer

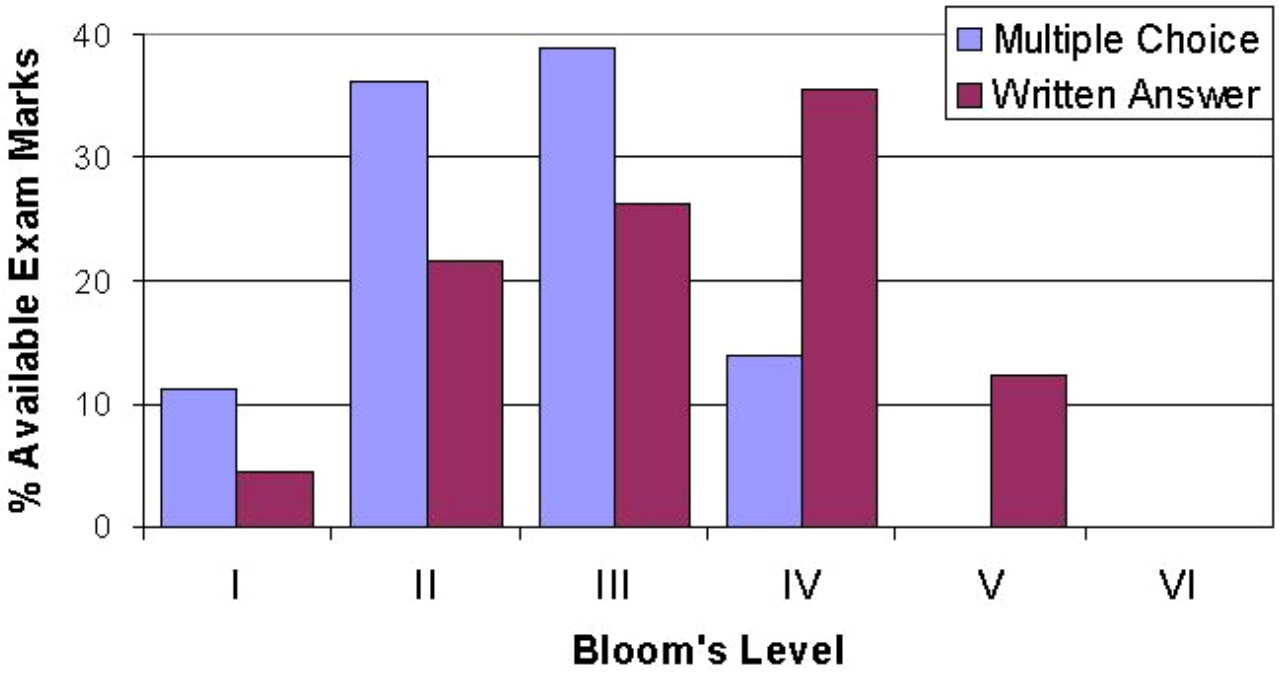

Figure 4: Percentage of Available Exam Marks at Each Level of Bloom's Taxonomy: A Comparison of Multiple Choice and Written Answer Questions (Averaged Data from Sections A, B, and C, Biology 121, Jan-Apr 2008)

Biology 121:
Recommendations for Learning Outcomes

Biology 121:
Current Learning Outcomes

57 course learning outcomes:

13 in Ecology

20 in Genetics
(12 core plus 8 non-core)

22 in Evolution
(8 core plus 14 non-core)

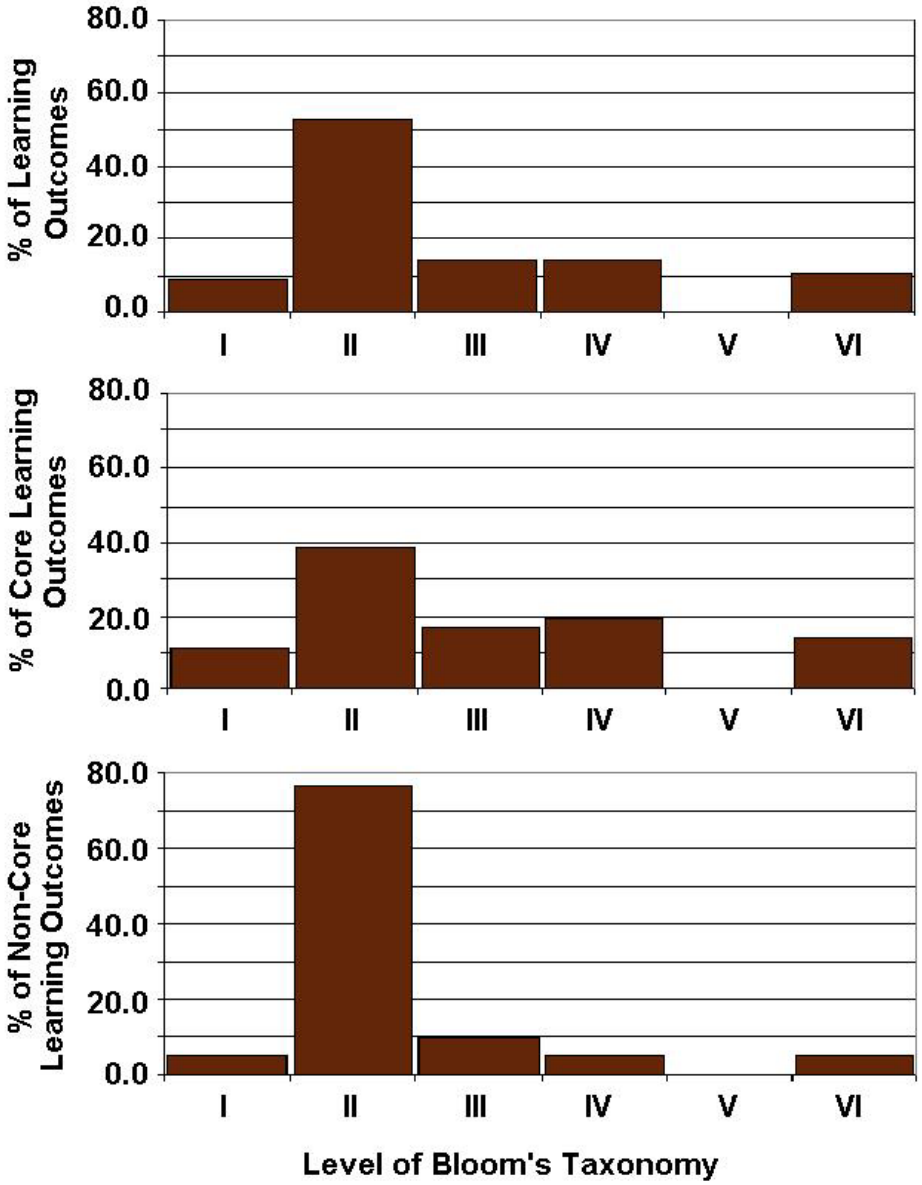

Figure 5: Percentage of Biology 121 Course Learning Outcomes at Each Level of Bloom's Taxonomy (Jan-Apr 2008)

Biology 121: Recommendations for Learning Outcomes

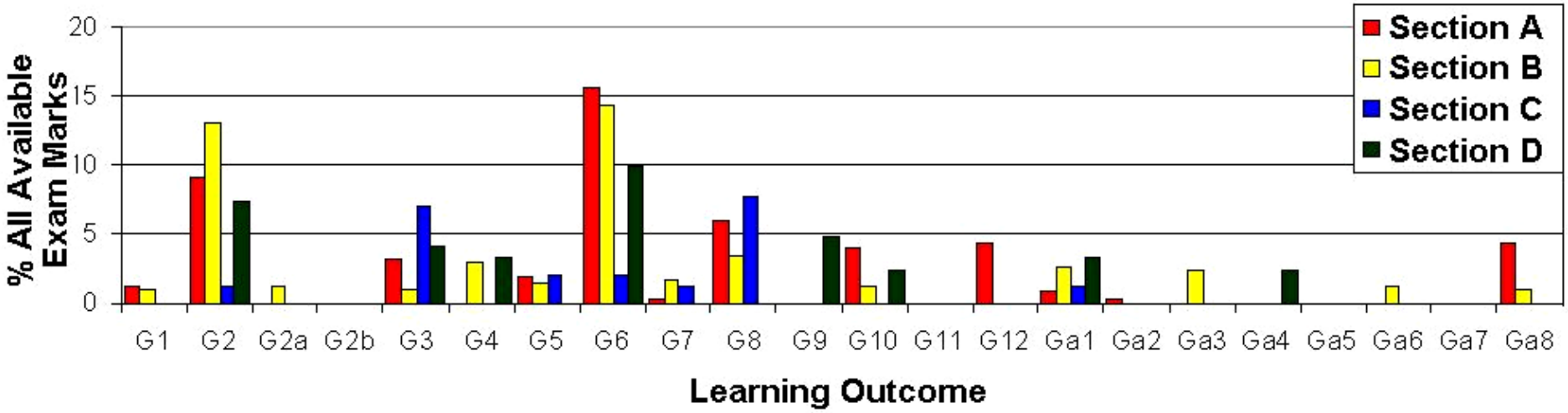

Figure 6: Assessment of Genetics Learning Outcomes: A Comparison Amongst Four Sections of Biology 121 (Jan-Apr 2008)

We used these results to make suggestions for streamlining learning outcomes such that all core learning outcomes can be covered in all sections while still leaving some class time for optional learning outcomes.

Biology 121: Recommendations for Learning Outcomes

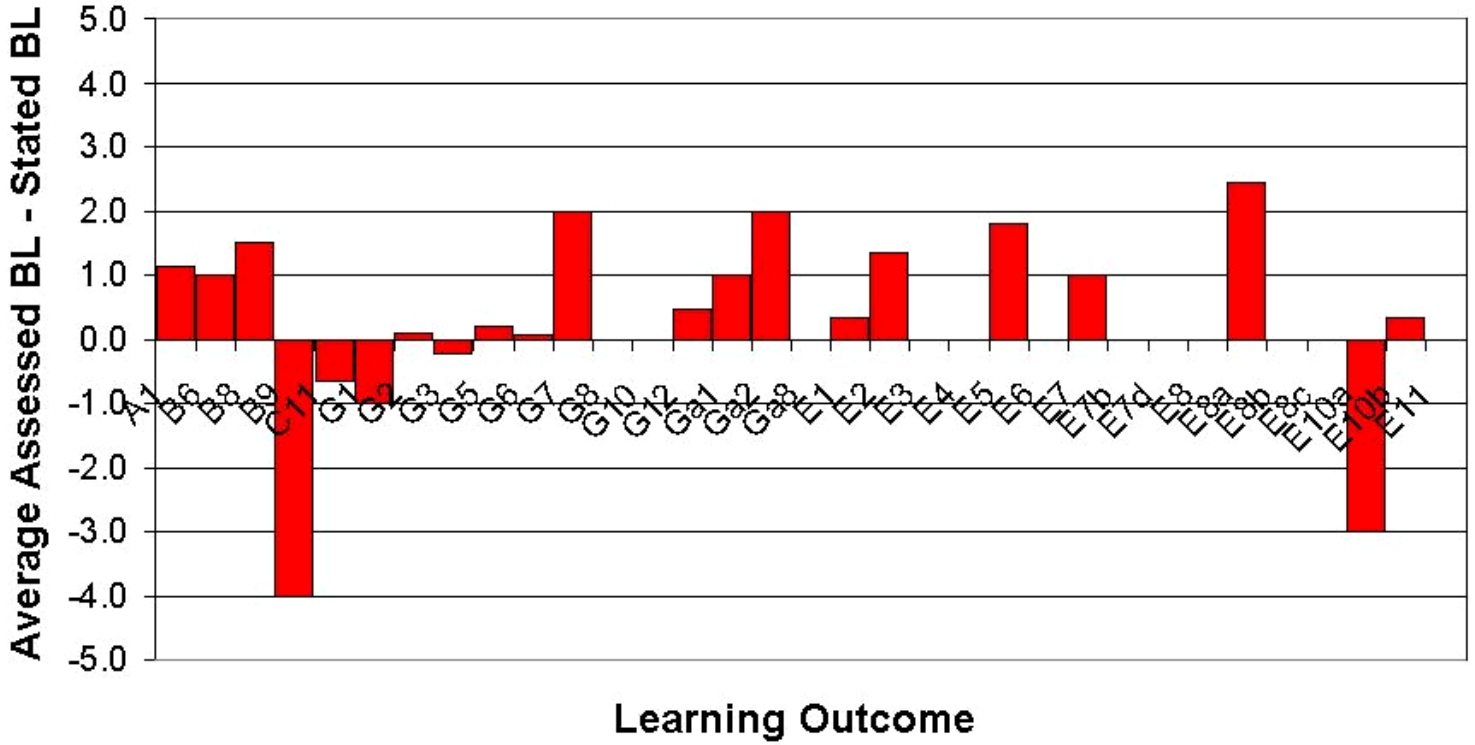

Figure 7: Differences in the Average Bloom's Level (BL) of Course Learning Outcomes as Assessed Compared to as Stated (Biology 121, Section A, Jan-Apr 2008)

We used these results to suggest wording modifications to learning outcomes such that they more closely represent the Bloom's Level at which they are assessed.

Biology 121: Recommendations for Learning Outcomes

Rewording of Learning Outcomes – Example: Evolution E9a

Original Wording: Describe how biologists study the history of the diversity of life on earth. (BL II)

Sample Exam Question: Having reached the Planet Zogor in a distant galaxy, humans disagree as to the origin of life on the planet. Some say it was planted on many occasions from distant galaxies. Others think it arose and diversified on the planet. What biological data would you collect to prove or disprove either hypothesis? (Use the earth's biodiversity as a model.)

Recommended Wording: Design tests to investigate the evolution of unknown life forms, based on practices currently or historically used by biologists to study the history of the diversity of life on earth. (BL V)

Biology 121: Recommendations for Learning Outcomes

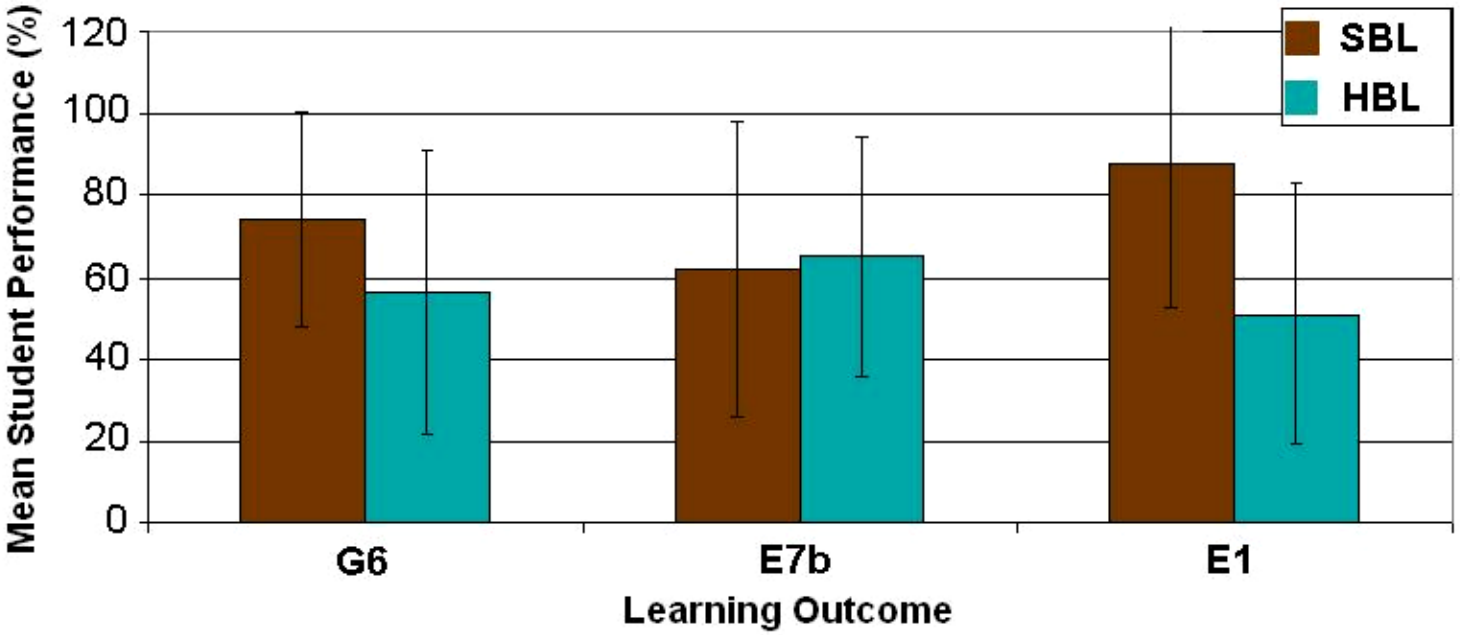

Figure 8: Student Performance on Exam Questions In Which Learning Outcomes are Assessed at the Bloom's Level Stated (SBL) Compared to Questions Where Learning Outcomes are Assessed at a Higher Bloom's Level (HBL) (Biology 121, Section B, Jan-Apr 2008)

Our preliminary data suggests that students perform better on exam questions in which learning outcomes are tested at the stated level than when learning outcomes are tested at a higher level.

Biology 121: Recommendations for Learning Outcomes

Our recommended learning outcome wordings would modify the Bloom's Level of learning outcomes to more closely reflect the level at which they are assessed such that they are a more useful study tool for students.

We recommended streamlining the learning outcomes by decreasing the number of core learning outcomes from 36 to 30, and having each instructor list their own non-core learning outcomes (rather than all possible non-core outcomes).

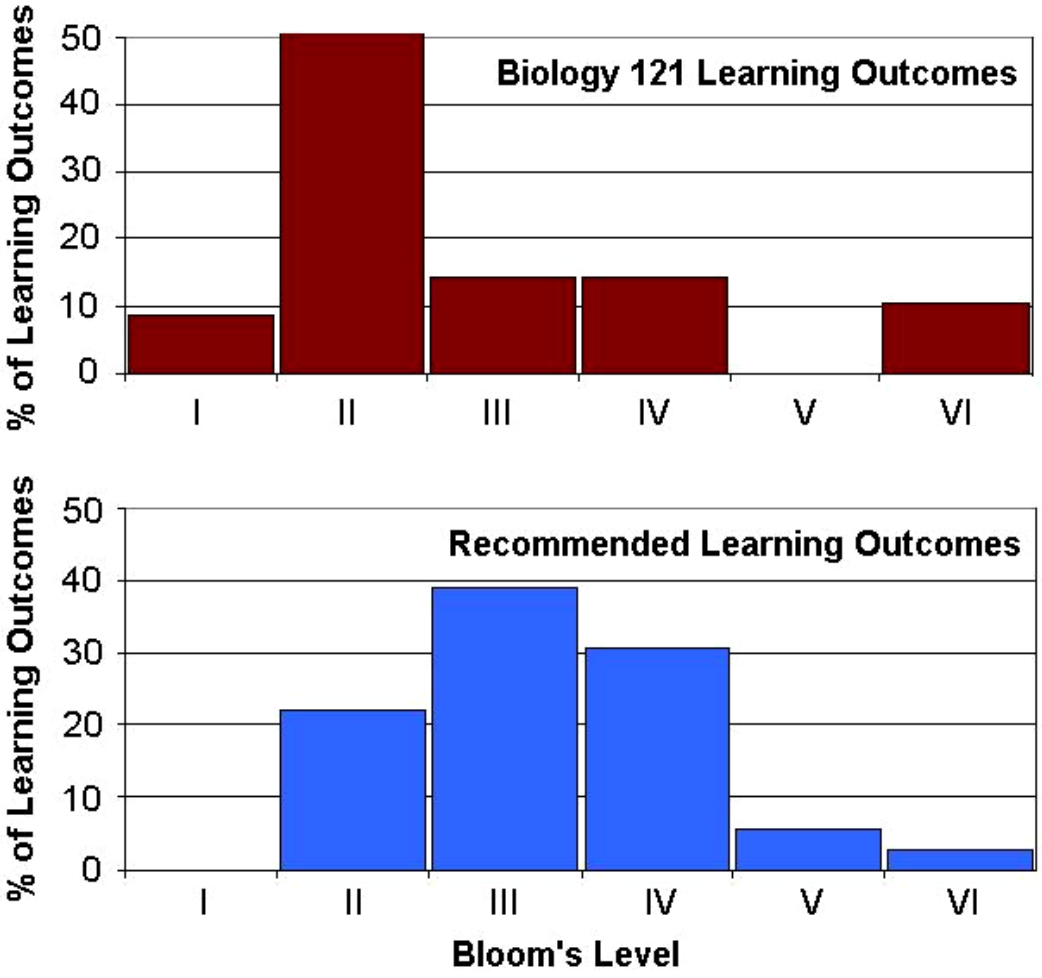

Figure 9: Percentage of Biology 121 Learning Outcomes at Each Bloom's Level: A Comparison of Course Learning Outcomes from Jan-Apr 2008 to Recommended Learning Outcomes