Cognitive alignment within introductory biology courses
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Methods
We collected all course objectives, formative and summative assessments used in introductory biology I and II taught in Fall 2014 and Spring 2015.

Goal 1: Characterize the cognitive skill levels of summative assessments
Goal 2: Quantify the alignment between formative (homework) and summative assessments
Goal 3: Examine the alignment between course objectives and summative assessments
Goal 4: Compare the cognitive skills assessed in traditional online courses

Research Goals
Our overall goal is to investigate the cognitive skills of introductory biology and the alignment across assessments and learning objectives

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Bloom’s Annotated Taxonomy

<table>
<thead>
<tr>
<th>Synthesis &amp; Evaluation</th>
<th>Analysis</th>
<th>Application</th>
<th>Comprehension</th>
<th>Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>integrate, modify, create, design, invent, judge, explain, decide, rank</td>
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<tr>
<td>analyze, separate, order, explain, connect, classify, arrange, infer, compare</td>
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<tr>
<td>apply, demonstrate, calculate, complete, illustrate, show, illustrate</td>
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<tr>
<td>summarize, describe, interpret, contrast, predict, associate</td>
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<tr>
<td>list, define, tell, describe, identify, show, label, collect, examine, etc.</td>
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Verb Cues

Example Questions

[...] Build a phylogenetic tree of vertebrates in the style of your choice (bracket or diagonal). Be sure to label all synapomorphies.

A female pigeon with a crest is crossed with a male that is homozygous dominant. What are the possible genotypes and phenotypes of their offspring? Show your work.

What is the ultimate source of energy for plants?

Conclusions

Everything that encapsulates a course, such as in-class instruction or group work, has not been completely captured in our data, but our data does show:

- Great diversity of cognitive skill items within one introductory biology course
- Students may experience different learning environments from section to section dependent upon instructor or type of course
- Our culminating goal is to help professors better align their summative assessments, homework, and course objectives to improve future students learning outcomes.

Online vs traditional

- Online and traditional courses approach students’ learning using primarily LOCS questions on summative assessments
- There is major variability in cognitive skill across learning environments
- There is a significant difference in the distribution of LOCS and HOCS for online and traditional ($\chi^2 = 89.2, p < 0.0001$)

Future Directions

- Provide professors with feedback on the cognitive skill levels of their course assessments
- Repeat study to see if feedback helped instructors better align course objectives and assessments
- Assess student success by item
- Examine of student study skills throughout course

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References