BioSkills Guide: Developing and Validating Learning Outcomes for the Core Competencies

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Why develop competency learning outcomes?

- *Vision and Change* (AAAS, 2011) described 6 core competencies (i.e. skills) for undergraduate biology, but intentionally kept descriptions brief to encourage discussion among educators.
- To facilitate teaching, mapping, and assessment of competencies across curricula, we aimed to…

Collaboratively develop and nationally validate a "BioSkills Guide": a set of measurable learning outcomes for the 6 core competencies for graduating general biology majors.

Vision and Change Core Competencies

- Process of Science
- Quantitative Reasoning
- Models & Simulations
- Interdisciplinary Nature of Science
- Communication & Collaboration
- Science & Society

Learning Outcome Development & Validation Overview

Draft Development
- Faculty-crafted draft (n≈20)
- Literature review
- Expert interviews (n=12)
- Workshops (n≈24)

Review
- Surveys (n=93)
- Interviews (n=15)
- Workshops (n≈115)
- ~60 reviewers per competency, spread over 5 rounds)

Repeat 5x

Revision

Pilot Validation
- Survey (n=20, 11-12 per competency)

Validation
- Survey

We Are Here

Expansion for Use
- Example activities
- References for published assessments, aligned by competency

What does the BioSkills Guide look like?

A ***portion*** of the BioSkills Guide draft for the competency "Process of Science" is shown below:

Outcomes accomplished during a 4-year degree program.

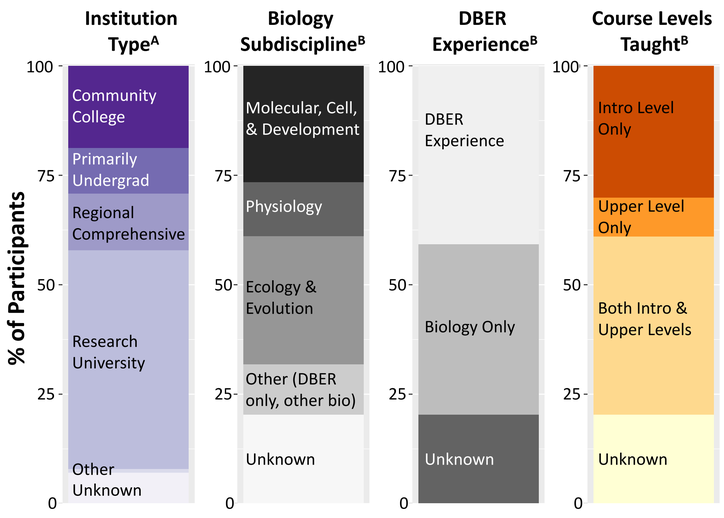
Outcomes accomplished in a single course.

Specific examples of teaching practices aligned with each outcome. *Not intended to be exhaustive or formally validated.

PROCESS OF SCIENCE

Program-Level Learning Outcomes	Course-Level Learning Outcomes	Examples of Activities and Assignments
INFORMATION LITERACY Locate, interpret, and evaluate scientific information.	Find and evaluate the credibility of a variety of sources of scientific information, including popular science media and scientific journals.	Carry out literature searches using databases, Google Scholar, and library resources. Compare treatments of similar science topics in primary literature, popular science media, and online discussions. Identify authors and conflicts of interest in web sources.
	Interpret, summarize, and evaluate evidence in primary literature.	Use primary literature reading guides such as those at www.scienceintheclassroom.org. Differentiate between the various parts of a research paper to find specific information (i.e., content and purpose of Results section vs Discussion section). Interpret and teach data figures to peers in jigsaw or small group settings.

Who reviewed the BioSkills Guide?



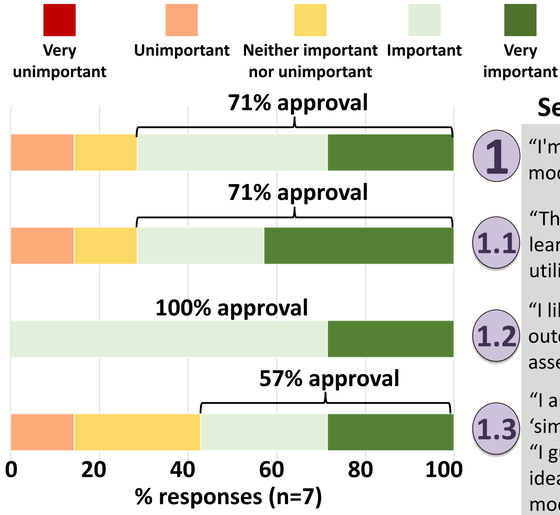
[A] Includes participants from surveys, interviews, and workshops, from Review and Pilot Validation stages (n≈243).
[B] Includes only survey respondents, from Review and Pilot Validation stages (n=113)

Example Review & Revision Process

Initial Outcomes:

	Program-Level Learning Outcomes	Course-Level Learning Outcomes	
1	MODEL-BASED THINKING Practice and report appreciation of a model-based way of thinking about biological systems.	Describe the nature and utility of models and compare the strengths and limitations of different types of models (e.g., mathematical, computer, conceptual).	1.1
		Build and revise conceptual models (e.g., diagrams, cartoons, concept maps) to show how a biological system or mechanism works.	1.2
		Define and simplify complex problems using models.	1.3

How important or unimportant is it for graduating general biology majors to achieve this outcome?



Selected Comments:

1 "I'm not sure what you mean by model-based way of thinking"

1.1 "This seems to cover two student learning outcomes: 1) nature and utility and 2) strengths and limitations"

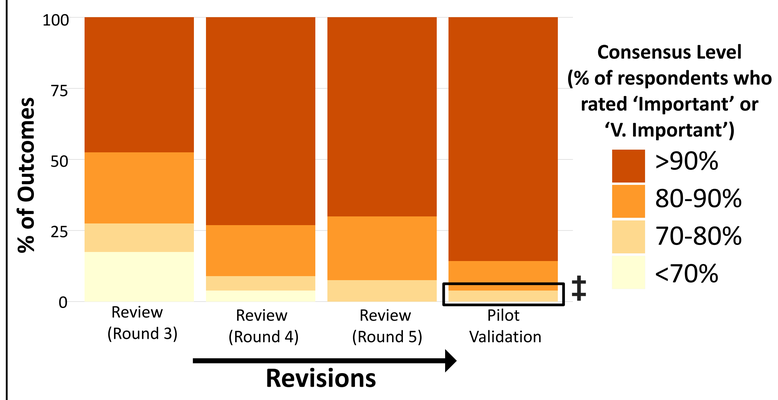
1.2 "I like the active nature of this outcome (and it is amenable to direct assessment)"

1.3 "I am unclear by both 'define' and 'simplify'"
"I guess I don't understand the whole idea of how to define a problem using models"

Revised Outcomes:

Program-Level Learning Outcomes	Course-Level Learning Outcomes
APPRECIATION OF MODELS Recognize the important and varying roles scientific models play in explaining and communicating biological phenomena.	Describe how scientists use models when solving problems and communicating biological concepts.
	Compare the strengths and limitations of different types of models (e.g., mathematical, physical, conceptual, animal).
MODEL DESIGN…	Build and revise conceptual models (e.g., diagrams, cartoons, concept maps) to show how a biological system or mechanism works.

Consensus on outcomes has grown with iterative revisions



‡
1. MODELING: Build and evaluate models of biological systems. – 73%
2. Build and revise conceptual models (e.g., diagrams, concept maps, flow charts) to propose how a biological system or process works. – 73%
3. Identify methodological problems and suggest solutions or alternative approaches. – 75%

Retained due to strong support from modeling experts

Retained due to strong support from modeling experts, and in previous review (100%)

Revised based on earlier draft with greater support (88%)

Recruiting participants for a 15-min. survey

To determine if the outcomes represent the views of the broader biology community, **we are currently looking for biology educators with a range of expertise (institution types, subdisciplines, course levels) to evaluate the outcomes via an online survey.** We would appreciate your input. Please write your name and email address on the sign-up sheet next to poster to participate.

Acknowledgments

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References

American Association for the Advancement of Science (AAAS) (2011) *Vision and Change in Undergraduate Biology Education: A Call to Action.* Washington, DC.