Validated Learning Objectives for Introductory Biology: A Resource for Improving Course Design, Faculty Practice, and Student Outcomes

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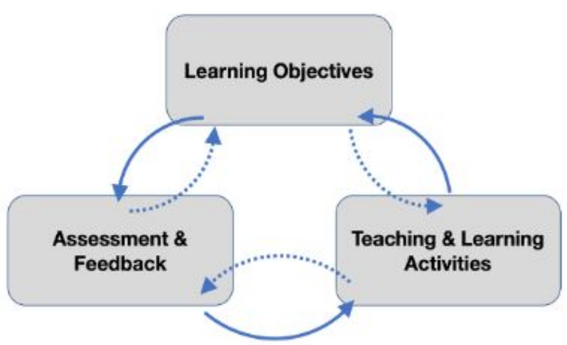
Abstract

Need:
Learning objectives (LOs) are statements of what students should know and be able to do. In a well-designed course, students and instructors understand the LOs, use activities to master those LOs, and test progress toward achievement with carefully aligned assessments. However, no common set of LOs has ever been proposed and validated for introductory biology. Instead, most instructors struggle to define the course goals or simply teach lists of textbook topics. This work builds on progress made from NSF-sponsored work: Vision and Change, the BioCore Guide, and the BioSkills Guide.

Guiding Questions:
This work has two aims: (1) produce a set of validated learning objectives for introductory biology; and (2) conduct research on faculty use of learning objectives, with a focus on developing an evidence-based teaching guide to support faculty; a comparative analysis of majors and non-majors LOs; and identifying barriers faculty face using LOs in course transformation efforts.

Outcomes:
We have developed LOs for majors (n= 352) and non-majors biology (n= 283). Both sets of LOs have undergone two of three rounds of review with faculty who have expertise in introductory biology content areas and active learning pedagogical practices. The LOs are currently in the process of national validation via a comprehensive survey. A user's guide to support faculty use of LOs is now in press at *CBE-Life Sciences Education* (Orr et al., 2022). Additionally, we completed a comparative analysis of course-level learning goals currently in use in the U.S. from majors and non-majors syllabi. The greatest percent of course level learning goals are rated Bloom's level 1 or 2 (46% non-majors; 47% majors) and competencies are present in 50% and 37% of non-majors and majors learning goals, respectively.

Broader Impacts:
With annual enrollments exceeding 500,000, majors and non-majors biology are two of the most consequential undergraduate STEM courses in the U.S. Research has shown that active learning increases achievement for all students and especially for populations underrepresented in STEM. Redesigning courses by aligning assessments and active learning exercises with learning objectives is the next frontier to improve student performance—a critical requirement for the U.S. to meet current and projected needs for qualified STEM professionals. These nationally validated learning objectives are a major ingredient for course transformation. This project opens a new field of inquiry on how faculty design courses and how the design impacts student performance.



Components of integrated course design (after Fink, 2003)

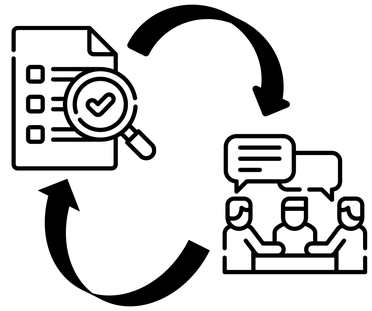
Process

Non-majors

Developed novel LOs

Majors

Developed LOs from Biology community & textbooks

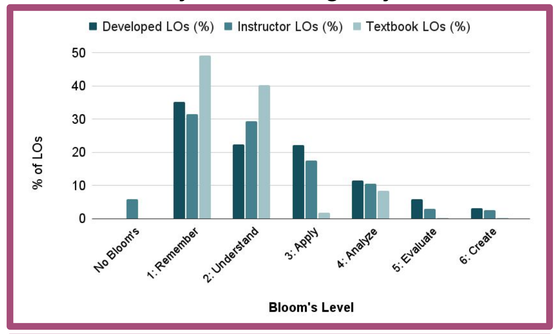


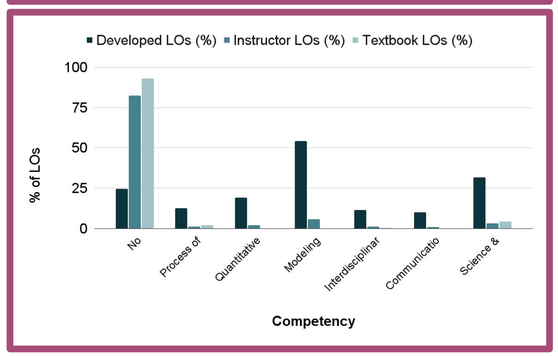
Review & Revise

Non-majors LOs **N=290**

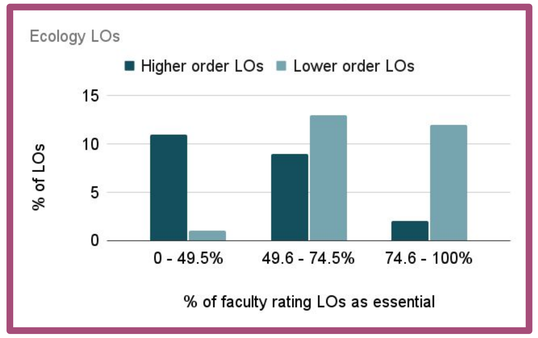
Majors LOS **N=**

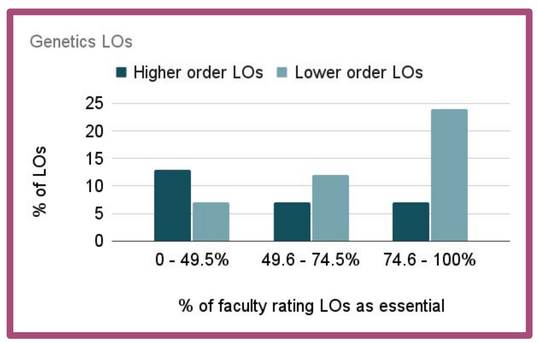
Non-Majors Learning Objectives





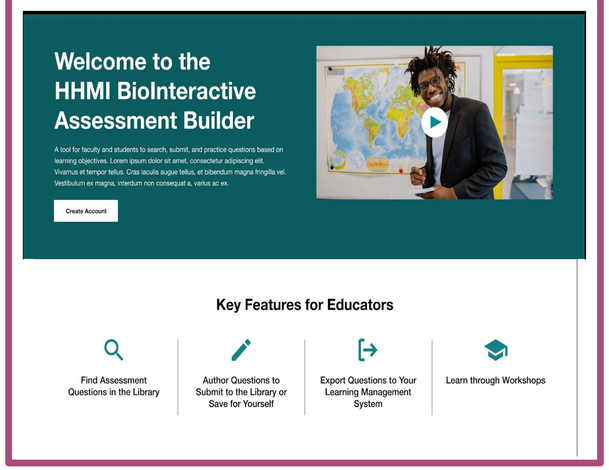
Majors Learning Objectives





Key Outcomes

- **42% of non-majors Developed LOs are higher-order,** as compared to instructors surveyed (33%) and textbooks (11%)
- **75% of non-majors Developed LOs include competencies**, as opposed to instructors surveyed (17.7%) and textbooks (7%)
- Faculty perceive lower-order majors LOs as more essential than higher order LOs.



Next Steps

- Interviews and survey to understand why faculty rate low level LOs as more essential than high level LOs.
- Professional development opportunities to improve use of LOs.
- LOs should be used as a framework for building course activities.
- Develop assessments to measure student progress in achieving the LOs.
- Students should be taught to use LOs. Student use of LOs may improve student learning outcomes.
- Develop learning progressions for advanced biology course LOs, based on these introductory level LOs.