

Writing and Using Learning Objectives

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ABSTRACT

Learning objectives (LOs) are used to communicate the purpose of instruction. Done well, they convey the expectations that the instructor—and by extension, the academic field—has in terms of what students should know and be able to do after completing a course of study. As a result, they help students better understand course activities and increase student performance on assessments. LOs also serve as the foundation of course design, as they help structure classroom practices and define the focus of assessments. Understanding the research can improve and refine instructor and student use of LOs. This essay describes an online, evidence-based teaching guide published by *CBE—Life Sciences Education (LSE)* at <http://lse.ascb.org/learning-objectives>. The guide contains condensed summaries of key research findings organized by recommendations for writing and using LOs, summaries of and links to research articles and other resources, and actionable advice in the form of a checklist for instructors. In addition to describing key features of the guide, we also identify areas that warrant further empirical studies.

INTRODUCTION

Learning objectives (LOs) are statements that communicate the purpose of instruction to students, other instructors, and an academic field (Mager, 1997; Rodriguez and Albano, 2017). They form the basis for developing high-quality assessments for formative and summative purposes. Once LOs and assessments are established, instructional activities can help students master the material. Aligning LOs with assessments and instructional practice is the essence of backward course design (Fink, 2003).

Many terms in the literature describe statements about learning expectations. The terms “course objectives,” “course goals,” “learning objectives,” “learning outcomes,” and “learning goals” are often used interchangeably, creating confusion for instructors and students. To clarify and standardize usage, the term “objective” is defined as a declarative statement that identifies what students are *expected to know and do*. At the same time, “outcome” refers to the results *measured* at the end of a unit, course, or program. It is helpful to think of LOs as a tool instructors use for describing intended outcomes, regardless of the process for achieving the outcome (Mager, 1997). The term “goal” is less useful. Although it is often used to express more general expectations, there is no consistent usage in the literature.

In this guide, “learning objective” is defined as a statement that communicates the purpose of instruction using an action verb and describes the expected performance and conditions under which the performance should occur. Examples include:

- At the end of this lesson, students should be able to compare the processes of diffusion, osmosis, and facilitated diffusion, and provide biological examples that illustrate each process.
- At the end of this lesson, students should be able to predict the relative rates at which given ions and molecules will cross a plasma membrane in the absence of membrane protein and explain their reasoning.

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TABLE 1. Levels of LOs (Rodriguez and Albano, 2017)

Type of LO	Scope and context	Description
Institutional	Broad, institution specific	<ul style="list-style-type: none"> • Typically called “student learning outcomes” • Communicate the major learning claims made about what students can expect from attending an institution
Programmatic	Broad, program specific	<ul style="list-style-type: none"> • Communicate the standards of knowledge and skills that students are expected to acquire by completing a degree or certification program
Course level	Broad, course specific, and student centered	<ul style="list-style-type: none"> • Communicate claims about what students can expect to learn in a course and guide the development and coordination of major sections or units within that course
Instructional	Specific and descriptive, module or lesson specific, and student focused	<ul style="list-style-type: none"> • Communicate what students need to know and be able to do and designed so that each assessment item/task used in the course can be linked to at least one LO • Granular enough to be introduced at the start of individual class sessions and reflect the content and skills being taught that day • Include 1) an action verb that states the performance expected of students, 2) the conditions under which the student is expected to demonstrate the knowledge and/or skill in question, and potentially 3) the criteria by which student mastery will be judged

^aHereafter, our use of the term “learning objectives” specifically refers to instructional LOs.

In terms of content and complexity, LOs should scaffold professional practice, requirements for a program, and individual course goals by communicating the specific content areas and skills considered important by the academic field (Rodriguez and Albano, 2017). They also promote course articulation by supporting consistency when courses are taught by multiple instructors and furnishing valuable information about course alignment among institutions. As a result, LOs should serve as the basis of unit or module, course, and program design and can be declared in a nested hierarchy of levels. For clarity, we describe a hierarchy of LOs in Table 1.

This article describes an evidence-based teaching guide that aggregates, summarizes, and provides actionable advice from research findings on LOs. It can be accessed at <http://lse.ascb.org/learning-objectives>. The guide has several features intended to help instructors: a landing page that indicates starting points (Figure 1), syntheses of observations from the literature, summaries of and links to selected papers (Figure 2), and an instructor checklist that details recommendations and points to consider. The focus of our guide is to provide recommendations based on the literature for instructors to use when creating, revising, and using instructional LOs in their courses. The *Effective Construction* section provides evidence-based guidelines for writing effective LOs. The *Instructor Use* section contains research summaries about using LOs as a foundational element for successful course design, summaries of the research that supports recommended practices for aligning LOs with assessment and classroom instruction, and direction from experts for engaging with colleagues in improving instructor practice with LOs. The *Student Use* section includes a discussion on how students use LOs and how instructor guidance can improve student use of LOs, along with evidence on the impact of LO use coupled with pretests, transparent teaching methods, and summaries of LO-driven student outcomes in terms of exam scores, depth of learning, and affect (e.g., perception of utility and self-regulated learning). Some of the questions and considerations that serve to organize the guide are highlighted in the following sections.

WRITING EFFECTIVE INSTRUCTIONAL LEARNING OBJECTIVES

Writing LOs effectively is essential, as their wording should provide direction for developing instructional activities and guide the design of assessments. Effective LOs clearly communicate what students should know and be able to do and are written to be behavioral, measurable, and attainable (Rodriguez and Albano, 2017). It is particularly important that each LO is written with enough information to ensure that other knowledgeable individuals can use the LO to measure a learner’s success and arrive at the same conclusions (Mager, 1997). Clear, unambiguous wording encourages consistency across sections and optimizes student use of the stated LOs.

Effective LOs specify a visible performance—what students should be able to do with the content—and may also include conditions and the criteria for acceptable performance (Mager, 1997). When constructing an LO, one should use an action verb to describe what students are expected to know and be able to do with the disciplinary knowledge and skills (Figure 3). Bloom’s taxonomy of cognitive skills provides a useful framework for writing LOs that embody the intended complexity and the cognitive demands involved in mastering them (Bloom, 1956; Anderson and Krathwohl, 2001). Assessment items and course activities can then be aligned with LOs using the Bloom-Biology Tool described by Crowe *et al.* (2008). However, LOs should not state the instructional method(s) planned to accomplish the objectives or be written so specifically as to be assessment tasks themselves (Mager, 1997).

Our *Instructor Checklist* provides specific recommendations for writing LOs, along with a link to examples of measurable action verbs associated with Bloom’s taxonomy.

COURSE DESIGN: ALIGNING LEARNING OBJECTIVES WITH ASSESSMENT AND CLASSROOM INSTRUCTION

Course designs and redesigns built around clear and measurable LOs result in measurable benefits to students (e.g., Armbruster *et al.*, 2009, and other citations in the *Course and Curriculum Design* and *Outcomes* section of this guide). LOs are established as the initial step in backward design

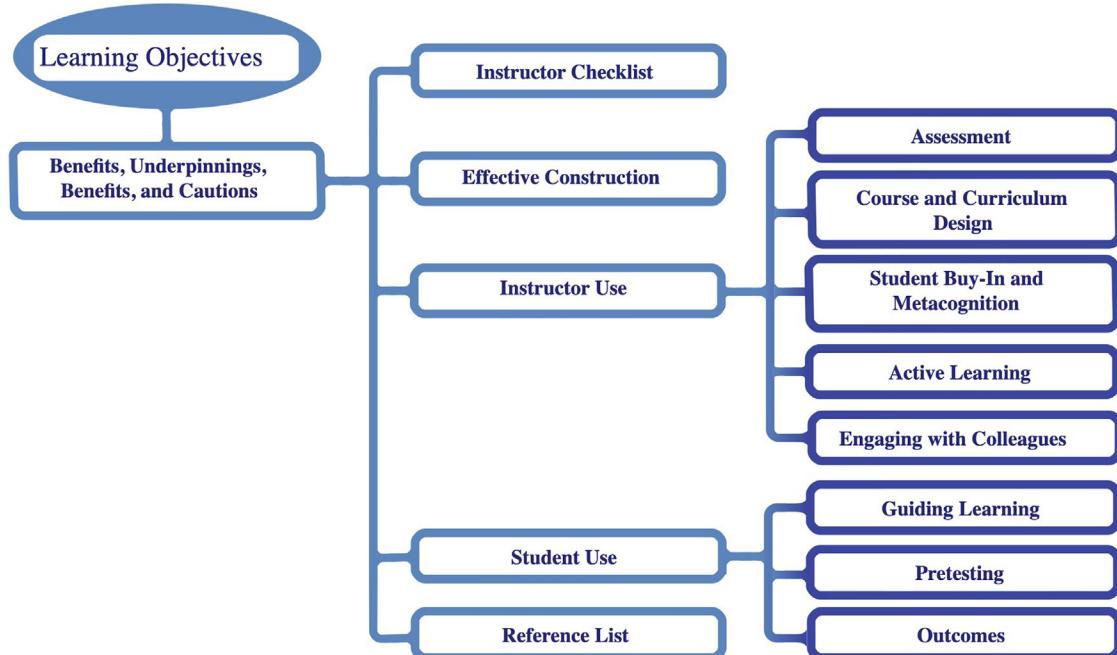


FIGURE 1. LO guide landing page, which provides readers with an overview of choice points.

(McTighe and Wiggins, 2012). They provide a framework for instructors to 1) design assessments that furnish evidence on the degree of student mastery of knowledge and skills and 2) select teaching and learning activities that are aligned with objectives (Mager, 1997; Rodriguez and Albano, 2017). Figure 4 depicts integrated course course design, emphasizing the dynamic and reciprocal associations among LOs, assessment, and teaching practice.

Used in this way, LOs provide a structure for planning assessments and instruction while giving instructors the freedom to be creative and flexible (Mager, 1997; Reynolds and Kearns, 2017). In essence, LOs respond to the question: “If you don’t know where you’re going, how will you know which road to take and how do you know when you get there?” (Mager, 1997, p. 14). When assessments are created, each assessment item or task

must be specifically associated with at least one LO and measure student learning progress on that LO. The performance and conditions components of each LO should guide the type of assessment developed (Mager, 1997). Data gathered from assessment results (feedback) can then inform future instruction. The *Assessment* section of our guide contains summaries of research reporting the results of aligning assessment with LOs and summaries of frameworks that associate assessment items with LOs.

The purpose of instruction is communicated to students most effectively when instructional activities are aligned with associated instructional and course-level LOs (e.g., Chasteen *et al.*, 2011, and others within the *Instructor Use* section of this guide). The literature summarized in the *Course and Curriculum Design* section of the guide supports the hypothesis that student learning is strongly impacted by what instructors emphasize in



Chasteen, S.V., Perkins, K.K., Beale, P.D.,

Pollock, S.J., & Wieman, C.E. (2011). A thoughtful approach to instruction: Course transformation for the rest of us. *The Journal of College Science Teaching*, 40, 24-30. The authors report the results of an upper-division physics course transformation using LOs to design instruction. A group of 10 instructors reached a consensus to share 75% of the LOs, leaving the remaining 25% up to the individual instructor. Instructors retained creativity and flexibility in their approach to teaching as the shared LOs did not dictate curriculum, instructional approach, or student/instructor interaction. The authors emphasize the



Armbruster, P., Patel, M., Johnson, E., &

Weiss, M. (2009). Active learning and student-centered pedagogy improve student attitudes and performance in introductory biology. *CBE – Life Sciences Education*, 8(3), 203-213. The authors report the results of an introductory biology course redesign over three years to improve student satisfaction and performance. Student enrollment each year ranged from 165-179 students. In the redesign, the content was reordered to teach specific content within conceptual themes. The redesign used the LOs as a “road map” to shape assessment and classroom activities, and exam and

FIGURE 2. Screenshots representing summaries of and links to selected papers.

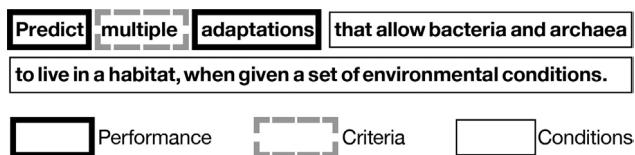


FIGURE 3. Components of an LO.

the classroom. In the guide's *Student Buy-In and Metacognition* section, we present strategies instructors have used to ensure that LOs are transparent and intentionally reinforced to students. When LOs are not reinforced in instruction, students may conclude that LOs are an administrative requirement rather than something developed for their benefit. The guide's *Instructor Checklist* contains evidence-based suggestions for increasing student engagement through making LOs highly visible.

Using LOs as the foundation of course planning results in a more student-centered approach, shifting the focus from the content to be covered to the concepts and skills that the student should be able to demonstrate upon successfully completing the course (e.g., Reynolds and Kearns, 2017, and others within the *Active Learning* section of this guide). Instead of designing memorization-driven courses that are "a mile wide and an inch deep," instructors can use LOs to focus a course on the key concepts and skills that prepare students for future success in the field. Group problem solving, discussions, and other class activities that allow students to practice and demonstrate the competencies articulated in LOs can be prioritized over lectures that strive to cover all of the content. The guide's *Active Learning* section contains a summary of the literature on the use of LOs to develop activities that promote student engagement, provide opportunities for students to practice performance, and allow instructors to gather feedback on learning progress. The evidence-based teaching guides on *Group Work* and *Peer Instruction* provide additional evidence and resources to support these efforts.

ENGAGING WITH COLLEAGUES TO IMPROVE LEARNING OBJECTIVES

Momsen *et al.* (2010) examined Bloom's level of assessment items and course goals from 50 faculty in 77 introductory biology courses for majors. The authors found that 93% of the assessment items were rated low-level Bloom's, and 69% of

the 250 course goals submitted were rated low-level Bloom's (Momsen *et al.*, 2010). A recent survey of 38 instructors of biology for nonmajors found similar results. Heil *et al.* (unpublished data) reported that 74% of the instructors surveyed write their own LOs, and 95% share their LOs with their students (Heil *et al.*, unpublished data). The action verbs used in 66% of these LOs were low-level Bloom's cognitive skills, assessing knowledge and comprehension (Heil *et al.*, unpublished data). Further, an analysis of 1390 LOs from three best-selling biology textbooks for nonscience majors found that 89% were rated Bloom's cognitive skill level 1 or level 2. *Vision & Change* competencies, as articulated in the *BioSkills Guide* (Clemmons *et al.*, 2020), were only present in 17.7% of instructors' LOs and 7% of the textbook LOs (Heil *et al.*, unpublished data). These data suggest that, in introductory biology for both majors and nonmajors, most instructors emphasize lower-order cognitive skills that are not aligned with teaching frameworks.

Researchers have documented effective strategies to improve instructors' writing and use of LOs. The guide's *Engaging with Colleagues* section contains summaries demonstrating that instructor engagement with the scholarship of teaching and learning can improve through professional development in collaborative groups—instructors can benefit by engaging in a collegial community of practice as they implement changes in their teaching practices (e.g., Richlin and Cox, 2004, and others within the *Engaging with Colleagues* section of the guide). Collaboration among institutions can create common course-level LOs that promote horizontal and vertical course alignment, which can streamline articulation agreements and transfer pathways between institutions (Kiser *et al.*, 2022). Departmental efforts to map LOs across program curricula can close gaps in programmatic efforts to convey field-expected criteria and develop student skills throughout a program (Ezell *et al.*, 2019). The guide contains summaries of research-based recommendations that encourage departmental support for course redesign efforts (e.g., Pepper *et al.*, 2012, and others within the *Engaging with Colleagues* section of the guide).

HOW DO LEARNING OBJECTIVES IMPACT STUDENTS?

When instructors publish well-written LOs aligned with classroom instruction and assessments, they establish clear goalposts for students (Mager, 1997). Using LOs to guide their studies, students should no longer have to ask "Do we have to know ...?" or "Will this be on the test?" The *Student Use* section of the guide contains summaries of research on the impact of LOs from the student perspective.

USING LEARNING OBJECTIVES TO GUIDE STUDENT LEARNING

Researchers have shown that students support the use of LOs to design class activities and assessments. In the *Guiding Learning* section of the guide, we present evidence documenting how students use LOs and how instructors can train students to use them more effectively (Brooks *et al.*, 2014, and other citations within this section of the guide). However, several questions remain about the impact of LOs on students. For example, using LOs may improve students' ability to self-regulate, which in turn may be particularly helpful in supporting the success of underprepared students (Simon and Taylor, 2009; Osueke *et al.*, 2018). But this hypothesis remains untested.

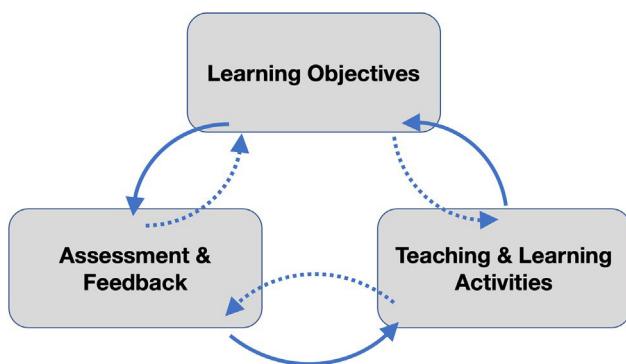


FIGURE 4. Components of integrated course design (after Fink, 2003).

There is evidence that transparency in course design improves the academic confidence and retention of underserved students (Winkelmes *et al.*, 2016), and LOs make course expectations transparent to students. LOs are also reported to help students organize their time and effort and give students, particularly those from traditionally underserved groups, a better idea of areas in which they need help (Minbiple, 2016). Additionally, LOs facilitate the construction of highly structured courses by providing scaffolding for assessment and classroom instruction. Highly structured course design has been demonstrated to improve all students' academic performance. It significantly reduces achievement gaps (difference in final grades on a 4.0 scale) between disadvantaged and nondisadvantaged students (Haak *et al.*, 2011). However, much more evidence is needed on how LOs impact underprepared and/or underresourced students:

- Does the use of LOs lead to increased engagement with the content and/or instructor by underprepared and/or underserved students?
- Does LO use have a disproportionate and positive impact on the ability of underprepared and/or underresourced students to self-direct their learning?
- Is there a significant impact on underserved students' academic performance and persistence with transparent LOs in place?

In general, how can instructors help students realize the benefits of well-written LOs? Research indicates that many students never receive instruction on using LOs (Osueke *et al.*, 2018). However, when students receive explicit instruction on LO use, they benefit (Osueke *et al.*, 2018). Examples include teaching students how to turn LOs into questions and how to answer and use those questions for self-assessment (Osueke *et al.*, 2018). Using LOs for self-assessment allows students to take advantage of retrieval practice, a strategy that has a positive effect on learning and memory by helping students identify what they have and have not learned (Bjork and Bjork, 2011; Brame and Biel, 2015). Some students, however, may avoid assessment strategies that identify what they do not understand or know because they find difficulty uncomfortable (Orr and Foster, 2013; Dye and Stanton, 2017).

Brooks *et al.* (2014) reported that about one-third of students surveyed indicated that they had underestimated the depth of learning required to pass an assessment on the stated LOs. Further, students may have difficulty understanding the scope or expectations of stated LOs until after learning the content. Research on how instructors should train students to use LOs has been limited, and many of these open questions remain:

- What are the best practices to help students use LOs in self-assessment strategies?
- How can instructors motivate students to go outside their comfort zones for learning and use LOs in self-assessment strategies?
- How can instructors help students better understand the performance, conditions, and criteria required by the LOs to demonstrate successful learning?
- How might this differ for learners at different institutions, where academic preparedness and/or readiness levels may vary greatly?

CAPITALIZING ON THE PRETEST EFFECT

The guide's *Pretesting* section contains research findings building on the pretesting effect reported by Little and Bjork (2011). Pretesting with questions based on LOs has been shown to better communicate course expectations to students, increase student motivation and morale by making learning progress more visible, and improve retention of information as measured by final test scores (Beckman, 2008; Sana *et al.*, 2020). Operationalizing LOs as pretest questions may serve as an effective, evidence-based model for students to self-assess and prepare for assessment. The research supporting this strategy is very limited, however, prompting the following questions:

- How broadly applicable—in terms of discipline and course setting—is the benefit of converting LOs to pretest questions?
- Is the benefit of operationalizing LOs to create pretests sustained when converting higher-level Bloom's LOs into pretest questions?
- Does the practice of using LOs to create pretest questions narrow students' focus such that the breadth/scope of their learning is overly limited/restricted? This is particularly concerning if students underestimate the depth of learning required by the stated LOs (Brooks *et al.*, 2014).
- Could this practice help instructors teach students to use LOs to self-assess with greater confidence and persistence?

STUDENT OUTCOMES

The guide concludes with research summaries regarding the specific benefits to students associated with the use of LOs. Specifically, 1) alignment of LOs and assessment items is associated with higher exam scores (e.g., Armbruster *et al.*, 2009, and others within the *Outcomes* section of the guide); 2) exam items designed to measure student mastery of LOs can support higher-level Bloom's cognitive skills (e.g., Armbruster *et al.*, 2009, and others within the *Outcomes* section of the guide); and 3) students adjust their learning approach based on course design and have been shown to employ a deeper approach to learning in courses in which assessment and class instruction are aligned with LOs (Wang *et al.*, 2013).

CHALLENGES IN MEASURING THE IMPACT OF LEARNING OBJECTIVES

It is difficult to find literature in which researchers measured the impact of LOs alone on student performance due to their almost-necessary conflation with approaches to assessment and classroom practices. We argue that measuring the impact of LOs independently of changes in classroom instruction or assessment would be inadvisable, considering the role that LOs play in integrated course design (Figure 4). Consistent with this view, the guide includes summaries of research findings on course redesigns that focus on creating or refining well-defined, well-written LOs; aligning assessment and classroom practice with the LOs; and evaluating student use and/or outcomes (Armbruster *et al.*, 2009; Chasteen *et al.*, 2011). We urge instructors to use LOs from this integrated perspective.

CONCLUSIONS

We encourage instructors to use LOs as the basis for course design, align LOs with assessment and instruction, and promote

student success by sharing their LOs and providing practice with how best to use them. Instructor skill in using LOs is not static and can be improved and refined with collaborative professional development efforts. Our teaching guide ends with an *Instructor Checklist* of actions instructors can take to optimize their use of LOs (<http://lse.ascb.org/learning-objectives/instructor-checklist>).

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