ESI Guidelines for Drafting Learning Objectives and Measurable Outcomes

Learning objectives and their associated measurable outcomes serve as a baseline set of substantive requirements for a proposed subject. Together, they define the capabilities and competencies students are expected to acquire by completing the subject and how instructors will measure a student's ability to achieve the subject's objectives.

I. What should Learning Objectives include?

Each learning objective statement should:

- Focus on student impact: Learning objectives should identify how student capability is expected to change as a result of completing the subject. For some subjects, learning objectives will outline what students will be able to do as a result of the class. For other subjects, learning objectives may articulate specific capacities for diagnosis, analysis, or action that students are intended to develop. We encourage both creativity and clarity in developing your learning objectives.
- Use action language: Using action verbs in the learning objectives statement helps pave the way to develop/identify student outcomes for the subject that can be measured. One common caution is to resist the (often strong) temptation to use phrases such as "will understand", "will develop intuition for", and "will learn," as they are broad and difficult to measure.
- Address the subject overall: The few lines of the statement should capture the top-level learning objectives for the subject, rather than every detail of what is covered in the subject.
- Be concise: Each statement should be roughly from one to four sentences.

For example…
A Learning Objectives statement for the subject "Thermal Energy" is given below, with the relevant action verbs shown in bold typeface.

Thermal Energy Learning Objectives:

After completion of this subject students will be able to:

1. **Use** the Second Law of Thermodynamics **to evaluate** the limitations on thermal-mechanical energy conversion in aerospace power and propulsion systems;

2. **Estimate** heat transfer rates in simple engineering situations such as a convectively cooled turbine blade,

3. **Carry out conceptual design** of basic aerothermal components and systems.

A resource (with caveat)

Guidance in developing learning objectives and measurable outcomes often refers to Bloom's Taxonomy of Educational Objectives (see http://teaching.uncc.edu/learning-resources/articles-books/best-practice/goals-objectives/writing-objectives). An updated version of Bloom's Taxonomy (see http://www.celt.iastate.edu/teaching/effective-teaching-practices/revised-blooms-taxonomy) may be a useful source for brainstorming the action-oriented language that is essential for good learning objectives/measurable outcomes.

The taxonomy and some ways in which it is used are subject to critique for oversimplification (see http://www.corwin.com/upm-data/13602_Chapter_1_Marzano_Final_Pdf_2.pdf and http://edglossary.org/blooms-taxonomy/, for example). We include it here as a prompt for creative thinking rather than as a philosophy of education.

II. Measurable Outcomes [and Methods of Assessment]

The measurable outcomes should be described at the level in which they are actually assessed in the subject. The number of measurable outcomes listed will vary between subjects; some have observed that useful sets of outcomes include somewhere between 5 and 15 distinct outcomes.

An example of measurable outcomes and assessment methods for Thermal Energy is given below. Again, the action verbs are shown in bold typeface. The assessment method is indicated in brackets.

1. **Explain** the physical content and implications of the second law in non-mathematical terms [concept quiz, quiz];
2. **Define** entropy [concept quiz, homework];
3. **Estimate** the thermodynamic efficiency and power production of an arbitrary ideal cycle [concept quiz, homework, quiz];
4. **Obtain** a basic physical intuition for the thermodynamic performance of real power and propulsion devices **as indicated by** recognition of what good, average, and poor performance is (metrics and numbers) for engineering power and propulsion devices [concept quiz, homework];
5. **Use** entropy calculations as a tool for evaluating irreversibility (lost work) in engineering processes [homework, quiz];
6. **Estimate** the effect of losses on thermodynamic efficiency [homework, quiz];
7. **Estimate** heat transfer rates for aerospace vehicle conditions [homework, quiz];
8. **Carry out** a thermodynamic analysis of a basic (real or proposed) power or propulsion producer, assess performance, and suggest where design improvements would be most effective [GE design project].

Note in outcome (4) above the ***desire*** is for the students to develop intuition but the ***measurable outcome*** is their recognition of typical performance levels.

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