Teaching Tips

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Learning: Objectives, Competencies, or Outcomes?

R.W. Hartel and E.A. Foegeding

There is considerable confusion about exactly what constitutes a learning outcome and how (or if) it is distinguished from learning objectives or competencies. Even in the education literature, the usage of these terms seems contradictory at times.

Sometimes it is instructive to find definitions in the dictionary. According to the American Heritage Dictionary, the learning terms are defined as follows: *Competency*: Competence. The state or quality of being competent. Properly or well qualified, capable. *Objective*: Something worked toward or striven for, a goal. *Outcome*: A natural result, consequence.

These definitions leave one unfulfilled when it comes down to the details of writing statements of student learning that can be used for assessment (in this case, we prefer the definition of an "objective" that relates to the microscope lens closest to the sample). The use of "competency," "objective," and "outcome" in education is somewhat more specific, and the new IFT Education Standards (http://www.ift.org/cms/?pid=1000427) were written to match the education field's general use of the terms. Working definitions for the learning terms may be written as follows:

Competency. A general statement detailing the desired knowledge and skills of student graduating from our course or program.

Objective. A very general statement about the larger goals of the course or program.

Outcome. A very specific statement that describes exactly what a student will be able to do in some measurable way. A competency may have several specific learning outcomes so a course typically contains more outcomes than competencies.

Objectives, competencies, and outcomes can be written to describe the learning gained by students in individual courses (course outcomes) or for the program as a whole (programmatic outcomes). The main distinction between objective or competency and a true learning outcome is that a learning outcome is written so that it can be measured or assessed. Thus, learning outcomes are the basis for an assessment program that focuses on what student can do either upon completion of a course or upon graduation from a program. Further details on learning outcomes can be found in Huba and Freed (2000).

Writing a learning outcome

The key to writing a truly assessable learning outcome is to use language that describes learning in such a way that it can be measured. To state that a student will understand or know some fact or topic is a good objective, but it is not easily measured. How do we tell whether a student really understands a concept? Generally, understanding accompanies the ability to use the concept. So a true learning outcome should focus on what we want the student to be able to do at the end of our course or the curriculum. Moreover, this allows us to determine a way to assess the student mastery of the outcome.

A good starting point for writing learning outcomes is Bloom's taxonomy (Bloom 1956), as shown in Table 1. The verbs associated with each level of Bloom's taxonomy (Bloom 1956) are a good starting point for writing learning outcomes at each lev-

MS 20040316 Submitted 5/14/04, Accepted 6/12/04, Revised 7/1/04. Author Hartel is with Univ. of Wisconsin, Dept. of Food Science, 1605 Linden Drive, Madison, WI 53706. Author Foegeding is with North Carolina State Univ., Dept. of Food Science, Raleigh, N.C. Direct inquiries to author Hartel (E-mail: rwhartel@wisc.edu).

Table 1—Bloom's taxonomy (Bloom 1956)

	Keywords
I. Knowledge: remembering information	Define, identify, label, state, list, match
II. Comprehension: explaining the meaning of information	Describe, paraphrase, summarize, estimate
III. Application: using abstracts in concrete situations	Determine, chart, implement, prepare, solve, use, develop
IV. Analysis: breaking down a whole into component parts	Point out, differentiate, distinguish, discriminate, compare
V. Synthesis: putting parts together to form a new and integrated whole	Create, design, plan, organize, generate, write
VI. Evaluation: making judgments about the merits of ideas, materials or phenomena	Appraise, critique, judge, weigh, evaluate, select

el. A good learning outcome will have the following characteristics. It will have a verb that identifies what action the student should be able to perform. It will also denote the conditions under which the student should demonstrate mastery. Finally, a learning outcome often contains some element of how that mastery may be evaluated.

Sample learning outcomes

There are many ways to write learning objectives for a course. Two samples are provided here, one in food engineering and one in food chemistry, simply to show different approaches. We recommend that each instructor develop his/her own approach, perhaps in collaboration with an education expert.

Food engineering

One of the core competencies in the food engineering and processing section of the IFT Education Standards relates to knowledge of mass and energy balances. It states that "the student should be able to use the mass and energy balances for a given food process." In fact, this competency is very close to a true learning outcome because one could conceivably measure how well a student can use these concepts.

However, the instructor must decide exactly what the student should be able to do after finishing the course. For example, a set of objectives/outcomes written specifically for mass balances might look like this:

1. Understand scope of importance of mass balances in food processing systems.
2. Describe the general principles of mass balances in steady state systems. (II)
3. Draw and use process flow diagrams, with labels on flow streams, for mass balance problems. (III)
4. Solve mass balance problems associated with food processing operations. (III)
5. Design and solve mass balances for complex process flow systems, including batch mixing problems, multiple stage flow problems, problems with multiple inflows and outflows, recycle streams and multiple components, and processes where chemical reactions take place. (V)
6. Understand appropriate use of mole fractions and mass fractions in mass balances.

The 1st and last items are not outcomes as we've defined it. They are better called learning objectives. Numbers 2 though 5, however, represent learning outcomes in that they can easily be measured or assessed in some way. They also contain an active (and assessable verb) followed by the specific conditions under which mastery is required. The Roman numerals associated with each outcome refer to the level of Bloom's taxonomy (Bloom 1956), as shown in Table 1.

To assess student mastery, we use traditional homework problems and exams, but these are supplemented by a semester-long group project where the students must write and solve their own engineering problems. With the project, we can easily assess the level of competency of each student group by judging the level of problem they write and whether they solve their problem correctly.

Food chemistry

Let's start with the core competency of "understand the chemistry underlying the properties and reactions of various food components." This is clearly much broader than the example given for food engineering; therefore, we must narrow the subject. We will focus on the Maillard Reaction. A possible (but not the only) set of outcomes are listed as follows:

1. Identify which simple sugars can participate in the Maillard Reaction. (I)
2. Describe the differences between a reducing and a nonreducing sugar. Which one participates in the Maillard Reaction? Why? (II)
3. Determine if the Maillard Reaction will occur under the following food processing situations. For each ingredient and processing factor, indicate why it increases, decreases, or has no effect on the Maillard Reaction (III)
4. For the following 2 lists of ingredients and processes for making low-sugar cookies, differentiate them on their propensity for Maillard Browning. (IV)
5. Design a "granola-like" bar that has the same sweetness, browning, and flavor as normal granola bars but conforms to the Atkins diet. (V)

Note that this series of outcomes can be assessed by various means. For numbers 1 and 2, you could have structures drawn that need to be identified, you could have student draw the structures, or you could just have them describe in words. At the other end of the spectrum, question 5 could be the subject of a semester-long group project. The common link is that they are written such that the student level of knowledge can be assessed. Once that is determined, you could decide whether or not the students have achieved the level of competency you desired or determine that you need to take another approach. The final result is a better understanding of what your students have learned and what was successful your teaching method.

Summary

The IFT Education Standards require learning outcomes to be written for each food science course. This will require many faculty members to rethink their approach to instruction. The 1st step in this approach is to understand the distinction between an assessable outcome and a general objective of competency. Several resources for outcomes and assessment include Diamond (1998) and Palomba and Banta (1999). Further details on assessment of learning outcomes can be found in the Guidebook for Food Science programs at the IFT web site (www.ift.org).

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