Chapter 29

Assessment and Instruction: Starting With the End in Mind

Susan Gomez-Zwiep and William J. Straits
Department of Science Education
California State University, Long Beach

As professionals, we are constantly tinkering with our instructional practice—trying new teaching strategies, writing our own lab manuals, improving assessments, reorganizing lecture notes—in an effort to more effectively facilitate student learning. Too often our efforts to (re)design units of instruction fail to yield the degree of increase in student learning hoped for. These disappointments arise in part as these efforts address only *how* we teach. A more fundamental question is *what* to teach? Difficulties with instruction and assessment can often be eased by casting a critical eye upon desired instructional outcomes.

Often, faced with a wide array of concepts to cover, we design our instruction to march our way through this content. This is not to say that this design is not undertaken in a meaningful and thoughtful manner, but that it is designed with the course of instruction primarily in mind. Wiggins and McTighe (2005) argue that rather than using this focus, we should start with a clear statement about the desired results of this instruction, our assessment. Three questions should be used to frame assessment goals:

- What should students know, be able to do/ what is "worth" knowing?
- What evidence will serve as proof that students have learned this content?
- What texts, activities, or methods will enable students the ability to provide that evidence?

In this "backward" design, Wiggins and McTighe suggest that we can only begin to think about our instructional strategies once we have established our goals and assessments.

It is important in planning for instruction and assessment that you decide what you want students to "know" by the end of a given unit of instruction. There are several factors to consider in determining course goals: be realistic about available resources as well as possible time constraints, refer to state and national standards for science teaching, and consider departmental, institutional, and personal mission statements. Most college science educators are familiar with content knowledge goals, however instructors may also choose to include process skill, application, intellectual development, attitudinal, motivation, and self-efficacy goals (see Straits and Wilke 2002 for additional possibilities). Most importantly, goals need to be teachable, attainable, appropriate, and accessible. Once goals have been established, instructors can begin to determine specific objectives for each instructional session. These objectives should be measurable outcomes that determine if course goals have been met and should be used to drive the design of instruction and assessments.

Prioritizing each of these learning objectives is a vitally important step in the instructional design process, as it helps to determine the expected level of student expertise. Certainly we prefer students to come to fully comprehend *all* that we cover over the course of the semester, however not all concepts are equally important. Is a particular concept something students should understand deeply and be able to apply or is it something students need to only to know and comprehend? The answer to this question helps determine the appropriate level of instruction and type of assessment needed.

Wiggins and McTighe suggest four "filters" to serve as guidelines for determining which ideas and processes are most important and should be taught and assessed in a manner that promotes long-lasting student understanding. The first of these filters deals with how important specific topics are to the subject and to students' lives beyond the classroom. "Big ideas" (for example, change over time, energy flow) that serve as overarching themes for the subject are often worthy of high prioritization. Next, consider the extent to which ideas are central to the discipline. Topics and processes that lie at the heart of the matter should also be priorities. The third filter relates to student preconceptions. This consideration is vitally important for us as science instructors, as many students come to our classes with misconceptions about the topics we teach. To counter this, topics frequently misunderstand must receive greater attention in both instruction and assessment. Finally, instructors must consider the potential a topic has for engaging students. Topics of high interest, such as those that apply to students' everyday lives, relate to current societal issues, or arouse students' curiosity simply because they're gross, amazing, or strange, have the potential to generate a sustained interest in the subject and are therefore worthy of emphasis.

Once the relative importance of topics has been determined, instructors can design assessments. Fortunately, there is a wide array of assessment techniques appropriate for college science teaching (see, for example, Angelo and Cross 1993; Straits and Wilke 2002; Lord, French, and Cross 2009). Assessments that require students to perform such tasks as data or case study analysis are much more appropriate for probing and generating deeper student understanding and should be used with high-priority topics. Multiple-choice questions, on the other hand, are best used as opportunities for students to demonstrate basic understandings of concepts. Overall, the cognitive demand of each assessment item should match the importance of the concept being assessed.

It is important to emphasize that instruction and assessment should be seamless and interdependent. Often we consider assessment as something that is done at the end of instruction, when the reality is we need to diligently and regularly monitor student progress throughout the school year to know if we are reaching our goals for student learning. If we are aware of where we want our students to go, we should be monitoring our students' progress all along as a gauge for how effective our instruction has been toward that goal. This feedback can inform instruction and signal needed instructional changes or revisions to the planned assessments before the lesson is concluded. These continual assessments, along with being clear about our instructional aims from the very beginning, ensure that our instruction remains in line with the goals we established.

References

Angelo, T., and K. P. Cross. 1993. *Classroom assessment techniques: A handbook for college teachers*. San Francisco, CA: Jossey-Bass.

Lord, T. R., D. P. French, and L. W. Cross, eds. 2009. *College science teachers guide to assessment*. Arlington, VA: NSTA Press.

Straits, W. J., and R. R. Wilke. 2002. Practical considerations for assessing inquiry-based instruction. *Journal of College Science Teaching* 31 (7): 432–435.

Wiggins, G., and J. McTighe. 2005 *Understanding by design*. Upper Saddle River, NJ: Pearson Education, Inc.