Using Your Tests to Drive Instruction

Robert D. Stair

In this age of high-stakes testing, we spend a great deal of time teaching students test-taking strategies for multiple-choice tests. We show our students how to beat the test by reading all of the answer choices and using a process of elimination – essentially getting into the head of the test writer and guessing what the intended response is rather than reasoning critically through the science.

The unfortunate reality is that these strategies teach students to "fool the test-makers" by making it look as if they know more than they actually do. In addition, the strategies are often effective because they involve mechanisms for dealing with poorly constructed questions rather than how to reason and formulate an answer. Is this really what we want to teach our students? We often have little control over the sub par questions that appear on high-stakes assessments, but we do control the tests that we ourselves use in our classrooms, and we can do better.

Why Use Multiple-Choice Questions?

Multiple-choice questions are widely used on science tests because many see them as easy to construct and easy to grade. But are these statements true if our goal is formative assessment rather than summative?

If the sole reason for testing a student is summative – that is to award a grade – this statement is definitely true. Grading from a key is easy and a grade can be quickly assigned. If the goal is a formative evaluation, however, more effort must be put into the analysis of the student's responses to ascertain what possible misunderstandings or misconceptions led to the selection of a particular incorrect answer.

Are multiple-choice questions easy to construct? Once again, if the goal were a summative evaluation of whether a student knows a specific fact or vocabulary word, the answer would appear to be "yes." But if we want a question that goes beyond simple recall, that probes more deeply and has diagnostic value in a formative sense, more effort will be needed in its construction. As science teachers concerned about advancing our students' understandings of science, it is this type of question that should receive more of our attention. It is the analysis of student responses to this type of question that allows us to tailor our future instruction to meet the needs of individual students.

What Makes a Good Multiple-Choice Question?

To write good multiple-choice questions, there are many things that should be kept in mind. Five such points are listed below:

- **Make certain that the science is correct.** If it is not, good students might be distracted by the inaccuracy.

  Flawed example:
  A bat hits a baseball. At the moment of contact, the ball exerts a 2-N force on the bat, and the bat breaks. What force did the bat exert on the ball?

No matter what the possible answer choices here, a knowledgeable student might be distracted by awareness that a 2-N force will not break a bat!

- **Word the question clearly so that it is free of ambiguity.**

  Flawed example:
  A material that can be hit without shattering is
  A. viscous.
  B. flammable.
  C. malleable.
  D. hard.

  Although this question attempts to ascertain whether a student recalls the definition of "malleable," an extremely poor definition is presented in the stem of the question. The result is that arguments can be made for the correctness of more than one answer choice. A "viscous" syrup can be hit without "shattering" as can something that is considered "hard" such as a block of wood. Even as a simple recall question, this one needs work!

- **Avoid double jeopardy!**

  Flawed example:
  A force of 3.0 N acts on a cart for 5.0 s. The cart has a mass of 6.0 kg and is initially at rest. What is the speed of the cart at the end of 5.0 s? What is its kinetic energy, in joules, at the end of 5.0 s?

  Again, no matter what the possible answer choices, if a student gets the first part of this question wrong, he or she will automatically get the second part wrong as well since the calculation of kinetic energy depends on the speed.

- **Whenever possible, phrase the question so that it can be answered without reading the answer choices.** Another way to state this is that a good multiple-choice question should make a good essay question if the answer choices were to be covered or eliminated. The student should be able to reason through the question and formulate an answer without having to read through all the possible answer choices. Stating the question in this way focuses the intended answer and avoids reducing the student's task to an attempt to guess what the teacher was thinking when the question was written.

- **Include some answer choices that have diagnostic value.** Teachers, more often than not, excel at knowing where students are likely to make mistakes. This skill should be utilized in the formulation of multiple-choice questions. Rather than listing one correct answer choice and several "throw-aways," include answers that would result from likely mistakes. In this way, specific incorrect choices can provide an indication of what the student does not understand or where a mistake has been made.

The list of criteria presented here is far from exhaustive, but it provides a starting point for any teacher wishing to improve their test-writing skills.

Where Will the Time Come From?

Meeting criteria such as those listed above requires a commitment of time. Without a doubt, it takes longer to construct good multiple-choice questions than it does to construct many of the questions that appear in high-stakes tests or in typical classroom tests. And then it takes more time still to analyze the results for each student and translate those results into an instructional course of action. This can be a daunting realization for classroom teachers who are already hard-pressed to find time for planning, preparation, and grading during the school day. For those teachers, we offer the following rays of hope:

1. We have scheduled a weeklong workshop on writing assessment items for science courses at Colorado School of Mines next July. More details will follow in the January issue of our *Reflections* newsletter.
2. Science Curriculum Inc. offers software for the analysis of your students' multiple-choice test responses – *Diagnostic Analysis*. Additional information about this software package can be found at www.sci-ips.com/DA3.html.
3. For users of *Introductory Physical Science* (*IPS*) or *Force, Motion, and Energy* (*FM&E*), we have assessment packages available that contain prepared multiple-choice and open-response questions for each chapter in the two textbooks. For more information, visit www.sci-ips.com/ips/assessment_pkg.html.