1

Introduction

Introduction—Opportunities

You're a good teacher. You really care about whether your students learn. So as you lecture you watch their faces for clues and ask yourself, "Do they get it? Are they enthusiastic about what I'm saying?" You stop and ask them, "Does anybody have any questions?" Students nervously look at each other. No one raises a hand. Good, you think to yourself, no one had a question—they must be following my presentation and understanding the subject.

If you're an experienced teacher, you know you shouldn't make that assumption. Many students will not call attention to what they don't know, especially in a large class. Research shows that instructors usually overestimate how much students learn. But now, *there's a better way!* Technology has advanced to the point where classroom response systems—or "clickers"—allow a teacher to sample the thinking of all students, at any time, without students having to risk embarrassing themselves in front of their peers.

Here's how the clicker system works. Each student has a transmitter (clicker) that looks very much like a small TV remote control. The clicker has a number of buttons labeled, for instance, a, b, c, d, and e. The classroom has one or more receivers that pick up the signals generated when a student pushes one of the buttons, and a computer equipped with appropriate software to record each student's response. Class results are usually presented without student names attached, typically as a bar chart that can be projected in front of the classroom showing how many students answered a, b, c, d, and e.

Experience shows that the use of clickers *transforms* the classroom, mostly in very positive ways. Student involvement increases. Students are suddenly active participants in class, not merely passive listeners to a lecture. As described in Chapter 6, "Clickers and Cooperative or Peer Learning," when students are allowed to discuss their answers with their neighbors before responding, the impact is even stronger. Another benefit is that class attendance increases. For instance, the University of Colorado

astronomy, planetary science, and physics faculty found that class attendance increased substantially, from 60–70% to 80–90%, after the introduction of clickers. The Illinois Institute of Technology (Burnstein & Lederman, 2001) reported 80–90% attendance in classes where clickers were used. Similar results have been reported from other universities. An important additional advantage to using clickers is that most faculty members enjoy the extra energy, variety, and student involvement clickers bring to a classroom.

Like any technology, though, clickers can be misused. This book will help you enjoy the benefits of clickers while avoiding the pitfalls. The wise use of clickers will help you:

   a. Measure what students know before you start to teach them
      (pre-assessment)
   b. Measure student attitudes
   c. Find out if the students have done the reading
   d. Get students to confront common misconceptions
   e. Transform the way you do any demonstrations
   f. Increase students' retention of what you teach
   g. Test students' understanding
   h. Make some kinds of grading and assessment easier
   i. Facilitate testing of conceptual understanding
   j. Facilitate discussion and peer instruction
   k. Increase class attendance

The remainder of this book highlights how clickers can help you meet your own goals in teaching while avoiding pitfalls we've seen in clicker systems. See your Addison-Wesley sales representative for more information on ready-to-use questions with clickers in your particular course and technology packages they can offer you and your students.

You don't need to be an expert teacher to use clickers. You may be brand new. Or, you may be a busy researcher without a lot of time to devote to teaching, but someone who wants her or his students to really learn science. In either case, this book is for you.

While clickers may be reasonably simple to use, the benefit you and your students derive depends substantially on how you and they use them. If you restrict yourself to factual recall questions and have students answer individually, your students will concentrate on memorizing facts and may consider clicker use a waste of time. If, instead, you follow the recommendations of Chapter 6 and use clickers to facilitate peer discussions and conceptual thinking, your students' learning will be deeper and their enthusiasm will be much greater.

What to Expect

As mentioned before, clickers will transform your classroom. While doing so, they may also contradict the expectations of your students (if they haven't had a "clicker class" before); and a surprised student is not necessarily a happy student. Suddenly, their absences from class are automatically recorded. Students can't sit in the back of a large lecture hall not paying attention (or sleeping) when every student is questioned and answers are recorded several times per class. Don't expect students to automatically welcome these changes. It is essential that you discuss with them the benefits clickers bring; otherwise they may concentrate on the disadvantages and be unhappy.

The use of clickers with conceptually based questions or peer discussions, both of which we recommend, strikes at an even more fundamental expectation—what it *means* to learn. Many science classes are still taught in such a way that students can memorize what the teacher says and then later repeat this on an exam and earn an excellent grade. These students often think they've mastered a subject. Scientists know, however, that genuine understanding means taking a concept and applying it to different situations or different kinds of problems, and being able to explain it to someone else. Clickers make it relatively easy to test, immediately, if students can do so. Once again, we recommend that you discuss with your class what you expect them to know before you start testing their knowledge.

An excellent strategy with clickers is to ask thought-provoking questions and evaluate the responses. If the class is split among several different answers, tell students you are going to give them another chance to answer, but first they should turn to their right and left and discuss with their neighbors what the correct answer should be. As experienced learners know, explaining something to someone else is a great way to develop your own understanding. But pause to consider what you've done: You've just told students to *talk during class*. You are contradicting years of their schooling, and when you first suggest it, students will often think you don't really mean it. Once they discover you are serious, the classroom will erupt into animated discussion, so much so that you will probably have to raise your voice to get their attention again. As Mazur (1997) observes, these discussions usually move the group toward the correct answer rather than an incorrect one, and student understanding and retention increase tremendously. However, the active classroom—one that uses clickers, or one that uses clickers plus discussion—requires more effort than sitting and copying notes, which may surprise students. Chapter 9 discusses student opinions.

Since the changes described above are disconcerting to many students, even as they improve students' learning, it is *imperative* that you discuss your expectations of clicker use at the beginning of a term. Tell the students why they will be using them, and how they will benefit. Tell them what you

consider cheating when using clickers. Explain the topics discussed in Chapter 2 and follow the checklist in Chapter 11. You and your students will be much happier.

This book is designed to help you get the most out of clicker use. At the University of Colorado, we began using clickers in 2002 and by the spring of 2004 used 6,000 per semester. At the University of Massachusetts, Amherst, 8,000 were in use in the spring of 2004. Use is spreading quickly, and most faculty members are happy with the results. Survey results from these universities and others are presented later in this book. Chapter 2 presents reasons you should use clickers and how student learning is likely to increase as a result. Chapter 9 presents evidence that students believe clickers improve their learning and that most students enjoy using them—when they are used wisely. Some references are given for further reading and for more detailed data on student performance. The main goal of this book, though, is to be self-contained and immediately practical. Follow the advice here and you can use clickers well. They can be one of the most effective and exciting additions to teaching that you've seen in many years. Good luck!