Chapter 1 | Engaging Students with Clickers

- Example 1.1 – Derek Bruff, Mathematics, Vanderbilt University (page 2)
  - Your sister-in-law calls to say that she’s having twins. Which of the following is more likely? (Assume that she’s not having identical twins.)
    - A. Twin boys
    - B. Twin Girls
    - C. One boy and one girl
    - D. All are equally likely
  - This example was given to students in a course on probability. The students were given a minute or two to think about the question without discussing with each other. Since only four of the sixteen students answered correctly, they were asked to discuss the question in pairs and vote again.
  - Figure 1.1 – Sample Results from First Vote
  - Figure 1.2 – Sample Results from Second Vote

Generating Classwide Discussions

- Case Study: Communication Studies – Michael Dorsher, Communication and Journalism, University of Wisconsin at Eau Claire (page 6)
  - The students were presented with the following ethical dilemma: Suppose you are an editor at the Washington Post, and the Unabomber has demanded that you print his thirty-thousand-word manifesto or he will continue sending mail bombs as acts of terrorism.
- Example 1.2 (page 7)
  - Question 1. As Post editor, which would you value most?
    - A. Upholding First Amendment independence from government
    - B. Increased readership
    - C. Maintaining credibility
    - D. Possibly helping save lives
    - E. Informing readers
    - F. Not acquiescing to terrorists
G. Possibly helping capture a criminal

Question 2. As Post editor, to whom do you most owe loyalty?
- A. The terrorist, who’s threatening you
- B. Future potential victims of the terrorist
- C. The surviving victims and families of dead victims
- D. The government
- E. Your readers/the public
- F. Yourself and other journalists

Question 3. With a top value of ____ and a top loyalty of ____, which ethicist would you follow?
- A. John Rawls: Protect the vulnerable; print the manifesto
- B. John Stuart Mill: The greatest good for the greatest number; don’t print it to uphold press independence
- C. Aristotle: The golden mean would be to excerpt it in the paper and publish it all online

This example was given to students in a course on mass media ethics. The first two questions were asking students to identify the value and loyalties that would be most important to them in this situation. Dorsher then lead a classwide discussion after each question. The third question asked the students to identify the ethical philosophy and course of action that best matches the most important value and loyalty identified in the previous questions. Although the third question would not be appropriate for a multiple-choice question on an exam or quiz because of the ambiguity, this ambiguity is a strength for class discussion. It creates the opportunity for students to share and discuss the reasons they have for selecting particular answer choices, thereby encouraging critical thinking.

Why Use Clickers for Classwide Discussions?
- Case Study: Biological Sciences – Adam Rich, State University of New York College at Brockport (page 10)
  - Rich teachers a sophomore-level course in anatomy and physiology. The clicker questions were used to generate classwide discussions that focus on the reasons for right and wrong answers to those questions in an effort to help students learn to build arguments. Rich posed a question to his students and has them submit their answers. Instead of displaying the results to the students, he facilitates a classwide discussion of the question while allowing students to change their answers at any time. This response system allows Rich to monitor the distribution of the responses as they change, providing him with information about how students are changing their minds during the discussion.
- Case Study: Language Instruction – Karina Kline-Gable, James Madison University (page 11)
  - Kline-Gable teaches intermediate- and upper-level Spanish courses. She uses clickers for oral exercises in her classes. She uses questions that are correct-incorrect or true-false questions. Although students are likely to guess at correct answers half the time, Kline-Gabel almost always follows such a question with another question that asks students for reasons for their answers. Since her students know that they will be asked to supply reasons for their responses, she finds that they tend to take the questions seriously and not guess randomly. The questions function to have students commit to answers to questions before a classwide discussion. This allows them to engage more actively in the discussion because they have a more vested interest in defending their answer choices.

Strategies for Leading Classwide Discussions (page 13)
1. Have students share the reasoning behind their answers to the clicker question.
2. Make sure to hear from students about each of the more popular answer choices.
3. If no student volunteers to defend or explain a particular answer choice, instructors might step in and suggest some reasons for that choice.
4. Encourage students to respond to and challenge each other’s comments during the discussion.
5. Refrain from making important points during the discussion if those points can be made by the students.
6. Sometimes students have trouble hearing each other’s comments during a classwide discussion.
7. Do not reveal the correct answer to a clicker question, if there is one, too soon.

Generating Small-Group Discussion

- Peer Instruction (PI)
- Case Study: Physics – Steven Pollock, University of Colorado at Boulder (page 15)
  - Pollock uses PI to engage students in his physics courses. After the vote that follows the PI time, if the students are split among more than one answer choice, he usually asks for volunteers to share reasons for their answers. He usually allocates two or three minutes for PI and asks four to six PI clicker questions during a fifty-minute lecture. Pollock likes to use questions that are conceptual in nature and also application questions to help students extend concepts to new contexts.

Why Use Clickers for Small-Group Discussions?

- Case Study: Language Instruction – Parvanak Fassihi, Boston University (page 17)
  - Fassihi teaches a course on academic writing for international students who are learning to write in a second language, English. She uses the clickers to generate small-group discussions. She gives a brief lecture on the topic, has her students identify sentences on a worksheet in groups of three or four, and then reviews the sentences with the entire class by using clicker questions. The students respond individually using their clickers, and Fassihi displays the results. If the results are mixed, she has the students return to their groups to discuss and then leads a class discussion about the topic.

- Case Study: Veterinary Medicine – Holly Bender, Iowa State University (page 18)
  - Bender teaches a course in veterinary pathology. She uses a three-class sequence for most topics. On day one, she lectures about the topic, asking clicker questions along the way to help students engage in the lecture. Her students complete two case studies as homework for the next class. On day two, she presents a third case study. The students answer a series of multiple-choice questions about the case, first individually and then as a team. She uses the team responses to lead a classwide discussion. On day three, she presents a fourth case that features several erroneous claims that are not supported sufficiently by the data. The students identify the claims first as individuals and then as teams. She gives each team a single clicker because she finds the resulting class dynamic highly effective. As a result, students answer the quiz questions on days two and three individually using answer sheets and as teams using clickers.

Frequently Asked Questions About Peer Instruction

- Should students respond to a clicker question individually before engaging in PI?
  - It encourages students to think independently and provides a chance for students to formulate a few thoughts they can bring to the PI time, creating the possibility of more productive small-group discussions
  - Results of a first, individual set of response can affect the pace of the class.
  - Ivan Shibley, a teacher of chemistry at Penn State Berks, does not have students answer questions individually prior to PI because of limited class time and because he feels his students do not have preconceived ideas about questions and topics in his course. He finds his students often need PI time in order to answer his questions.
  - If students are fairly enthusiastic about discussing course content, instructors may find that they welcome the chance to jump right into small-group discussions.

- Under what conditions should instructors skip PI after students respond individually?
  - If a clicker question has a single correct answer and that answer is clearly the most popular one.
    - If an instructor suspects that students answer correctly without having thought deeply about their responses, then PI time may be appropriate.
  - If a clicker question has a single correct answer but one of the incorrect answers is clearly the most popular one, then the question is likely one that students find challenging, and PI time is likely to be productive.
If two or more of the answer choices turn out to be popular among students’ individual responses, then the stage is set for productive PI time.

- What instructions should students be given for PI time?
  - Instructors can instruct students how to form pairs or small groups in different ways.
    - “Pair up with a student nearby”
    - “Find a student nearby who answered differently from you”
  - Instructors can specify the task in which the pairs or small groups should engage.
    - “Share the reasons you have for your answer with your partners”
    - “Convince your partners that you have the correct answer”
    - “Come to a consensus with your partners on an answer choice”
  - Adam Lucas, who teaches mathematics at Saint Mary’s College in California, finds that social dynamics can be a serious issue and that he needs to be proactive with seating arrangements and instructions for class discussions.

- Should each small group submit a single response following PI time?
  - Gives each group a specific goal for their discussion time which can help students focus their attention and energy.
  - Instructors who grade group responses on accuracy provide additional motivation for students to engage seriously in group discussion and consensus building.

- What should instructors do during PI time?
  - Many instructors find it useful to circulate among students as they discuss a clicker question during PI time.
  - Instructors might stop and interact with a group of students, asking questions of them in order to prompt them to consider issues and cases not already discussed in the group.
  - Teaching assistants, when available, can be instructed to circulate among students.
  - If it is not possible to walk among and interact with students during PI time, instructors might stand at the front of the classroom and observe students to get a sense of how quickly they analyze the question at hand and submit their answers and a sense of how many of them are staying on topic in their small-group discussions.

- How might an instructor lead a classwide discussion following PI time?
  - The strategies for leading more general classwide discussions apply equally as well to classwide discussions that follow PI time.
  - If students answer a question twice, instructors can ask a student who changed his/her answer during the PI time to share with the class the reasons for that change.
  - Ask for a student who did not change his/her answers to share with the class reasons why he/she did not find peers’ arguments persuasive.
  - Ask to hear from a group about the arguments shared during the group discussion time that were most persuasive.

Creating Time for Telling
  - Case Study: Chemistry – Dennis Jacobs, University of Notre Dame (page 27)
    - Jacobs teaches introductory chemistry courses, which are often large with around 240 students per section. His clicker questions ask students to predict the results of classroom chemistry demonstrations. He finds that by the time students respond to the question individually, discuss the question with their peers, respond to the question again, and participate in a classwide discussion, they really want to know how the experiment turns out.

Why Use Clickers to Create Times for Telling
  - Case Study: Psychology – Edna Ross, University of Louisville (page 30)
Ross teaches psychology courses which tend to be large with as many as 350 students. She uses clicker questions to create times for telling. For example, she finds that her students usually have difficulty distinguishing between classical and instrumental conditioning. She finds that the act of clicking an answer choice is a way of committing to that answer, which hooks the students into the learning process.

**Strategies for Creating Times for Telling**
1. Design questions that trap students around common misconceptions and ideas that are intuitive but not accurate.
2. Demonstrate to students that they are wrong about the question is as dramatic a way as feasible in order to increase their surprise at being wrong.
3. Plan for an explanation that is as helpful to the students’ understanding as possible.
4. Having student volunteers share their reasoning for choosing the correct answer to a question can be productive.

**Structuring Class Time**
- Case Study: Biological Sciences – Barnes, Christensen, & Hansen, 1994; Herreid, 2007 (page 33)
  - Instructors using the case study method of instruction typically provide students with a description of a real or fictional problem or situation.
  - Herreid (2006) proposes the use of classroom response systems to facilitate “interrupted case studies.” Students read and respond to a case study during class. They are given part of the case study and asked a serious of application and critical thinking clicker questions about each part.

**Why Use Clickers to Structure Class Time?**
- Many instructors see value in structuring a class session into a sequence of activities as a way to help students maintain their attention during an entire class.
- Structuring a class session helps students pay attention, and structures that include activities can also help focus their attention in productive ways on particular tasks.
- Clickers can be used to gather information from students in order to determine the direction of a class session, giving all students a voice in determining that direction.

**Making Class More Fun**
- Case Study: Mathematics – Meredith McCoy, Columbia State Community College (page 36)
  - McCoy teaches mathematics courses that students take in preparation for college algebra. She used the clicker questions to facilitate competitive games. Students complete their assigned questions as quickly as they can and submit their answers using their clickers. The game engages students because it is competitive but not punitive – students compete to be the fastest responder for a correct answer, but they also receive full points for a correct answer even if they are not first to respond. It works especially well when helping students prepare for tests.

**Why Use Clickers to Make Classes Fun?**
- A little fun can help students maintain attention and engagement with course activities.
- Instructors who help their students enjoy their classes a little more often find that this helps establish a useful rapport with their students.
- Some students find competition motivating.
- Clickers allow instructors to incorporate elements of popular television game shows into a college or university learning experience.

**Chapter 2 | Assessing Students with Clickers**

**Uncovering Student Learning**
- Case Study: Environmental Sciences – Thomas Benzing, James Madison University (page 40)
Benzing teaches a course on environmental issues in science and technology. In a typical fifty-minute class period, he might ask between six and eight clicker questions. He poses a question, has students respond individually using their clickers, displays the results without indicating the correct answer, and then asks for volunteers to explain popular choices, which leads to a classwide discussion of the question. An advantage Benzing sees in using clickers is that they let him hear from all students who do not understand a particular topic, not only those who are vocal in expressing their confusion.

Why Use Clickers to Uncover Student Learning?

- Using classroom response systems to practice agile teaching is a kind of formative assessment, a term used to describe assessment that provides “feedback to improve teaching and learning.”
- The anonymity that clickers provide students can sometimes be used to uncover student perspectives that might not be clear to instructors through other means of assessment.
- Students benefit when they are able to determine what they understand, what they do not understand, and how they are learning.
- Instructors learn a lot about what their students understand and with what they struggle by analyzing their performance on midterm exams, papers, and other major assessments in a course. Assessing student learning more frequently through clicker questions can provide similar information on student learning that can be acted on before major assessments are assigned.
- Clickers enable instructors to collect information on student learning from all students in a classroom quickly, easily, and simultaneously.

Occasions for Formative Assessment Using Clickers

- Example 2.1 – Weston Dripps, Earth and Environmental Sciences, Furman University (page 45)
  - Dripps teach earth and environmental science courses and uses clickers to assess his students’ understanding of environmental issues at the beginning of units in his courses.
  - Question 1. Global warming could lead to be shutdown of the North Atlantic’s ocean circulation pattern causing global cooling.
    - A. Strongly agree
    - B. Moderately agree
    - C. Moderately disagree
    - D. Strongly disagree
  - Question 2. In response to global warming, more extreme weather events like tornados striking Los Angeles and baseball-size hailstones pummeling Japan are likely.
    - A. Strongly agree
    - B. Moderately agree
    - C. Moderately disagree
    - D. Strongly disagree
  - Question 3. If the West Antarctic ice sheet were to melt, how much would the global sea level rise?
    - A. Less than 1 foot
    - B. 3 feet
    - C. 20 feet
    - D. 100 feet
    - E. 300 feet

- Example 2.2 – Ron McClamrock, Philosophy, State University of New York at Albany (page 46)
  - McClamrock uses clickers to conduct background knowledge probes at the beginning of individual class sessions in the philosophy courses he teaches.
  - What do you think of this claim? “Since it’s possible that everything we experience is a big, complicated illusion (or a virtual reality simulation), we don’t really know anything about the world (like that there are tables and chairs, or that I have a body).”
A. I think that’s generally right.
B. I disagree. Even if it’s possible that everything we experience is an illusion, that doesn’t mean we don’t actually know about the external world.
C. I don’t think it’s at all possible that everything we experience could be an illusion at all.
D. I don’t understand, or have no opinion.
E. This convinces me I should have taken English.

Frequently Asked Questions About Agile Teaching

- How might an instructor respond if most students answer a clicker question correctly?
  - An instructor might start by saying something like, “Answer choice B was the most popular choice. Would someone who chose B mind sharing with the class why they thought that answer choice was correct?” If students are reluctant to volunteer, this might be a sign that many of them are not sure of their answers.
  - If an instructor is convinced that most of the students understand the question reasonably well, he/she might reveal the results of the vote to the students and confirm for the students that the popular answer was the correct one.
  - Even when most students answer a question correctly, it is often productive to spend a little time reviewing the question and its answer choice with the students.
  - Because understanding why certain answer choices are incorrect is often as useful to students as hearing an explanation of a correct answer, instructors might say a few words about each of the incorrect answer choices for the question at hand or have students volunteer some thoughts on the incorrect choices.
  - It is often worth investigating whether students actually understand the question as well as the clicker results would indicate.

- How might an instructor respond to mixed clicker results?
  - Explain the question, the correct answer, and the incorrect answer to the students.
  - It can be helpful to have a few students share their reasons for their answers with the class before providing an explanation of the question and its answer choices.
  - Students might need to spend more time and effort thinking about it. It can facilitate a classwide discussion of the question, one with the goal of helping students arrive at a correct answer by weighing the various arguments their peers make about the question and its answer choices.
  - Have the students reengage with the question in some fashion, then have them answer the question again with their clickers, submitting the same or different answers than they did the first time.
    1. Ask students to discuss the question is pairs or small groups.
    2. If the students already discussed the question in pairs or small groups, have the pairs or small groups combine into double-sized groups to continue their discussion of the question.
    3. Provide the students with one or more hints about the question or a brief mini-lecture on the topic of the question, one that provides new information or reminds students of pertinent information they have already seen without giving away the answer to the question.
    4. Eliminate one of the answer choices for the students, explaining why that answer choice is incorrect.
    5. For each of the more popular answer choices, ask for a student volunteer to share reasons for choosing that answer.
    6. For challenging questions, it is sometimes possible to facilitate a classwide discussion about the question without confirming the correct answer for the students.

- How might an instructor respond if most students answer a clicker question incorrectly?
  - Spend more class time, either immediately or in the future, on the topic at hand.
  - If the question is as challenging as the initial clicker results would indicate, having students discuss the question among themselves might not help them make progress on understanding.
It can be helpful for an instructor to provide a few hints about the question or to spend a little time lecturing on the topic of the question before having the students vote again.

- Share the initial clicker results with the students and let them know that most of them answered the question incorrectly.
- Return to the topic in a subsequent class period after having time to plan an appropriate response.

- How might instructors use a question with multiple correct answers, some of which may be more or less reasonable, for formative assessment?
  - These are often used to help students develop their critical thinking skills since answering these questions requires students to evaluate the strengths and weaknesses of several possible responses.
  - It can be important to know how many students selected each of the correct answers, a distribution that a classroom response system can provide.
  - It is often useful to have a few students share their reasons for their selections.
  - Instructors must decide when to tell students that the question at hand does not have a single correct answer.

- When should instructors move on to the next topic?
  - Moving on depends on the amount of assistance an instructor wants to provide students on the topic.
  - Moving on depends on what comes after the question at hand. If the next topic depends on a thorough understanding of the topic, then it might be worth spending more time on the question.
  - Instructors should consider the level of engagement of their students. Knowing students’ engagement and motivation levels can be important in interpreting the results of a clicker question.

- What should instructors do about students who answer incorrectly when it is time to move on?
  - Clicker questions with answer choices constructed intentionally to surface student misconceptions allow an instructor to determine which difficulties and misconceptions are troubling the most students. This allows instructors to respond to the difficulties and misconceptions that challenge the largest number of students in a class.
  - Using class time to resolve commonly occurring misconceptions and questions is an efficient use of time.
  - Invite students who still have questions after a class discussion to see the instructor after class or in office hours.
  - Many instructors post clicker questions to their course Web sites or online course management systems in order to provide students with opportunities to reflect further on the questions. Making clicker questions available for student review after class is critically important to the impact such questions have on student learning.
  - Audio-recording a class session in which clicker questions are discussed and making it available to students after class is another option.
  - Watch for students who consistently answer clicker questions incorrectly.

**Two Advanced Techniques**

  - Lesson plans consist entirely of clicker questions. Which questions asked depends on how students respond during class. As students perform well on clicker questions, the instructor moves on to question on new topics. As students perform poorly, the instructor asks further questions on the same topic. PI and classwide discussion are used throughout the class session to help students master course content and develop critical reasoning skills.

- **Backchannel (page 62)**
  - Asking questions such as, “How well do you understand the lecture thus far?” Answer choices might range from “1. I’m following everything” to “5. Nothing makes sense.” Students can change their response to the question at any time and the instructor can monitor the response throughout the class.
  - Classroom response systems that allow free-response questions not just multiple-choice questions, can be used effectively in this fashion (displaying the average student response on a line graph that change in
real time like a heart-rate monitor) functioning as a backchannel by which students can submit questions and comments during a lecture.

**Evaluating Student Learning**
- Case Study: Health and Physical Education – Lori Paluti, Community College of Allegheny County (page 63)
  - Paluti teaches fitness walking and aerobic kickboxing courses. She uses the clickers for in-class quizzes that focus on the skills she teaches as well as basic wellness concepts. She poses a multiple-choice quiz question, gives all her students time to answer, displays the bar chart and correct answer, and then moves on to the next question. The students appreciate getting instant feedback on their work.

**Why Use Clickers to Evaluate Student Learning?**
- Case Study: Biological Sciences – Mary Burke, Oregon State University (page 66)
  - Burke teaches an upper-level microbiology course for biology, premedicine, and nursing major students. She uses a classroom response system to facilitate in-class exams. Students enter their exam version in their clickers as well as their answers to the multiple-choice questions. Students can answer at their own pace, in any order they wish, and to change their responses to questions already answered. After class, Burke transfers each student’s exam grade from her classroom response system to the student’s printed exam copy, which she returns in the next class session.

**Ideas for Summative Assessment Using Clickers**
- Reading Quizzes (page 67)
  - One way to encourage students to complete reading assignments is to administer a reading quiz using clickers at the start of a class session. The results can help shape the remainder of the class session as the instructor response to expressed student difficulties with the reading.
  - Corly Brooke, Human Development, Iowa State University
    - She gives her students five-question quizzes eight times during the semester. She announces them ahead of time and allows students to bring one page of notes to use. The quizzes constitute 10 percent of the course grade. The quizzes work to motivate students to complete course readings.
  - Elizabeth Cullingford, British Literature, University of Texas at Austin
    - Prior to the first exam, she asks students to answer a few questions at the start of each class session. One question regarding information from the previous lecture, one regarding the reading assignment, and a third designed to test students’ close reading skills. The clicker questions motivate her students to keep up with the readings for the course at least until the first exam, at which point it is clear to most students how important the readings are in the course.
  - Kori Street, History, Mount Royal College
    - She asks a series of basic questions about the reading assignment at the start of each class. Students who do not answer a sufficient number of these questions correctly are told to leave the class session immediately and complete the reading assignment. Her reading quizzes work well and end any problems with students not doing the reading within the first two weeks of class. Her students do not find her system punitive since it does not lower their grades as long as they are prepared for class.

- Homework Quizzes (page 68)
  - Allows instructors to grade student responses quickly and to review the results of the quiz immediately after collecting responses.
  - Stacy Kelin, Biomedical Engineering, Vanderbilt University
    - She asks clicker questions about her students’ homework assignments at the beginning of her courses. These questions motivate her students to complete their homework in part because they know they will be held accountable for it and in part because they know the homework will be discussed during class in context of these quizzes.
• Exams (page 68)
  o For longer assessments, an asynchronous mode is helpful.
  o Karina Kline-Gabel, Spanish, James Madison University
    ▪ She uses a classroom response system with a student-paced mode for exams. The exams consist
      of multiple-choice questions that focus on grammar and vocabulary, followed by free-response
      questions that assess students’ second-language writing skills. Once finished, the students move
      on to a writing portion of the exam. This format warms up the students for the writing portion.
      The classroom response system Kline-Gabel uses allows her monitor students’ responses as they
      submit them with their clickers.

Chapter Three | A Taxonomy of Clicker Questions

Content Questions

Recall Questions
  • These questions ask students to remember facts, concepts, or procedures relevant to a class session or course.
    They do not assess students’ understanding of these facts, concepts, or procedures, merely their memory of them.
  • Example 3.1 – Lori Paluti, Health and Physical Education, Community College of Allegheny County (page 73)
    o To which position do your hands return after throwing an offensive punch?
      ▪ A. Guard
      ▪ B. Pyramid
      ▪ C. Resting

Conceptual Understanding Questions
  • They can be useful for promotion enduring understandings of course material – conceptual understandings that
    will last far beyond the duration of the course itself.
  • Example 3.2 – GoodQuestions Project, Cornell University Department of Mathematics (page 75)
    o What is the equation of the line tangent to the function \( f(x) = |x| \) at the point \((0, 0)\)?
      ▪ A. The equation of the tangent line at this point is \( y = 0 \)
      ▪ B. There are two tangent lines, with equations \( y = -x \) and \( y = x \)
      ▪ C. This function has no tangent line at this point
      ▪ D. This function has infinitely many tangent lines at this point

Conceptual Questions in Quantitative Disciplines
  • Stacy Klein, Biomechanics course, Vanderbilt University (page 77)
    o She asks her students a conceptual question about a particular topic before having them engage in
      computational questions on that topic. She finds these questions help students understand the big picture
      of a problem before delving into complex computations.
  • Example 3.3 – Eric Mazur, Physics, Harvard University (Mazur, 1997) (page 78)
    o Think fast! You’ve just driven around a curve in a narrow, one-way street at 25 miles per hour when you
      notice a car identical to yours coming straight toward you at 25 miles per hour. You have only two
      options: hitting the other car head on or swerving into a massive concrete wall, also head on. In the split
      second before the impact, you decide to:
        ▪ A. Hit the other car
        ▪ B. Hit the wall
        ▪ C. Hit either – it makes no difference
  • Example 3.4 – Barbara Reisner, Chemistry, James Madison University (page 80)
    o Which solution best represents HCL disassociation in solution? (What does the equilibrium picture look
      like?)
      \[ \text{HCL}_{(aq)} \leftrightarrow \text{H}^+_{(aq)} + \text{Cl}^-_{(aq)} \]
Application Questions

- Example 3.5 – Rafael Gely, Law, University of Cincinnati (page 81)
  - Based on the facts of problem 7 [in the students’ textbook], in the lawsuit by the student against Mountain Law School, a court will likely find in favor of the:
    - A. student, if the court finds that the terms of the catalogue are complete, definite, and certain.
    - B. student, since catalogues are usually considered ads, and ads are always offers.
    - C. law school, since catalogues can never include all the necessary terms to be deemed definite and complete offers.
    - D. law school, since the student could not have expected to be taught all the terms included in the catalogue.

- Example 3.6 – Kristen Hessler, Philosophy, State University of New York at Albany (page 82)
  - Question 1. You promised to meet your friend Jim at 2:00 P.M. to help him with his philosophy homework. At 1:00 P.M., another friend, Sally, calls to ask for your help with her math homework, but you hadn’t made any promise to her. You estimate that helping one would produce an equal amount of food as helping the other. Due to other constraints on your time, you can’t help both. What should you do?
    - A. Help Jim
    - B. Help Sally
  - Question 2. You are on your way to help your friend Jim with his homework, as you promised. On the way, you pass an accident scene. You realized you could save someone’s life by pulling the person from a burning car, but that would mean that you would have to break your promise to Jim. What should you do?
    - A. Save the accident victim and break your promise
    - B. Help Jim and ignore the accident victim
  - Question 3. What, according to utilitarianism, accounts for your different intuitions about whether you should keep your promise in the previous two cases?
    - A. Whether you can consistently will that your maxims be universalized
    - B. The amount of good produced by keeping your promise compared to the other option in each case
    - C. The different motives of our actions in each case
    - D. The existence of different duties of different strengths

Procedural Questions

- This is a common type of application question, particularly in quantitative disciplines which requires students to apply knowledge of a procedure or technique to a particular problem or situation.
- Example 3.7 – Margaret Logan, Chemistry, State University of New York at Brockport (page 84)
  - ___ NH₃ (g) + ___ O₂ (g) → ___ NO (g) + ___ H₂ (l)
    - A. 2, 5, 2, and 3
    - B. 3, 6, 3, and 4
    - C. 4, 5, 4, and 6
    - D. 5, 5, 5, and 6
Example 3.8 – Adam Luca, Mathematics, Saint Mary’s College of California (page 85)

Which of the following is an incorrect step when finding the definite integral \( \int_0^4 x^2 \sqrt{1 + x^3} \, dx \) by the substitution method?

- A. \( u = 1 + x^3 \)
- B. \( \frac{du}{3} = x^2 \, dx \)
- C. \( \frac{1}{3} \int_1^{65} \sqrt{u} \, du \)
- D. \( \frac{1}{3} \int_0^4 \sqrt{u} \, du \)

Prediction Questions

- Having students make predictions and commit to them by submitting them with their clickers can help them become more invested in seeing and understanding the results of an experiment.

Example 3.9 – Bruce Atwood, Mathematics, Beloit College (page 86)

How does the plot of \( \sin(2t) \) compare to that of \( \sin(t) \)?

- A. It oscillates twice as fast
- B. It oscillates half as fast

Critical Thinking Questions

- These questions require students to analyze relationships among multiple concepts or make evaluations based on particular criteria.

Example 3.10 – Elizabeth Cullingford, English, University of Texas at Austin (page 87)

Do you think Chaucer’s portrait of the Prioress’s “conscience” and charity is meant to make us:

I. A. sympathetic toward her love of animals?
II. B. critical of her misplaced priorities?
III. C. aware that women are more tender-hearted than men?

These lines suggest that:
A. Hamlet really loved Ophelia and is so distraught to learn of her death that he proposed to eat a crocodile.
B. Hamlet thinks that Laertes’s grief is mere posturing and mocks it by exaggeration.
C. Hamlet cares little for Ophelia, but is eager to enter into a rhetorical chest-thumping competition with her brother.

Example 3.11 – Barbara Reisner, Chemistry, James Madison University (page 90)
- Reaction rates increase as the temperature of a reaction increases. Identify any statements that can be used to explain this phenomenon:
  I. Molecules collide more frequently at higher temperatures.
  II. More molecules have sufficient energy to react.
  III. More molecules collide with the correct orientation.
- A. I only
- B. II only
- C. I and II
- D. II and III
- E. I, II, and III

One-Best-Answer Questions
- Example 3.12 – Stuart Beatty, Pharmacy, Ohio State University (page 91)
  - Question 1. RR is a 22-year-old Mexican American newly diagnosed with type I diabetes. He weighs 68 kg. You need to start him on an insulin regimen. He has no insurance, did not complete high school, and speaks limited English. What is the best insulin regimen to start him on?
    - A. Glargine 15 units at bedtime plus sliding-scale lispro with meals
    - B. NPH 30 units twice daily
    - C. Mixed insulin 70/30, 20 units in the morning and 10 units at bedtime
    - D. Glargine 15 units at bedtime and lispro 5 units with meals
    - E. Levemir 15 units twice daily
  - Question 2. Two weeks later, RR comes in for follow-up. He brings his SMBG log book, and you see that most of his prebreakfast numbers have been high – around 200. After questioning RR, he says he has been waking in the middle of the night with a lot of sweating. The most likely reason for his high AM sugars is:
    - A. Dawn phenomenon
    - B. Poor dinner choices
    - C. Not enough insulin in the evening
    - D. Somogi effect
    - E. Incorrect use of BG meter

Example 3.13 – Ron McClamrock, Philosophy, State University of New York at Albany (page 92)
- We’ve looked at three problems for interactive dualism: the unintelligibility of interaction, Occam’s razor/explanatory simplicity, and the mental effects of physical trauma. Which do you think best succeeds in giving at least some decent reason to worry about the dualist view?
  - A. Unintelligibility of interaction
  - B. Occam’s razor/explanatory simplicity
  - C. Mental effects of physical trauma
  - D. None is best, but at least two are some reason to worry
  - E. None is any reason to worry about dualism at all

Since in-class clicker questions are often used more for engaging students than assessing them, these questions need not have single correct answers.

Peer Assessment
• Some instructors have students assess each other’s presentations, papers, or other work during class with clickers. This provides students with potentially valuable feedback on their work and helps students better understand the criteria by which quality is judged in a particular course or discipline.

• Megan Bowler, librarian, Mount Royal College (page 95)
  o Bowler often leads information literacy sessions for students. In some sessions she has students work in small groups on the scholarly quality of Web resources. Each group reports its assessments to the entire class, identifying each Web resource as appropriate for use in an academic paper or not. Then the students respond to a clicker questions: “Do you agree with this assessment – yes or no?” If there is significant disagreement, classwide discussions will follow.

• Kori Street, History, Mount Royal College (page 95)
  o Street includes a couple of problem-based learning activities in which students tackle complex problems that require them to practice thinking, reasoning, and usually debating like historians and to critically evaluate issues from multiple perspectives. Students will present their information and peers evaluate each group’s presentation using clicker questions based on a Rubric Street designed for this purpose.

**Free-Response Questions**

- These types of questions can be useful when instructors are not sure how students will respond to a question, making the construction of answer choices difficult. Free-response questions are not frequently used with classroom response systems due to the technological limitations of most such systems and the fact that multiple-choice questions are much simpler to use for assessment or engagement purposes.

**Process Questions**

**Student Perspective Questions**

- An instructor can ask students a variety of clicker questions that are not designed to assess their learning but to surface their perspectives instead. These questions can be used to help instructors get to know their students.

- Example 3.14 – Philippa Levine, History, University of Southern California (page 99)
  o Which of the following statements most closely matches what you think?
    ▪ A. Humans evolved from other life forms with divine assistance
    ▪ B. Humans evolved from other life forms without divine assistance
    ▪ C. Humans were created directly by a divine being within the past 10,000 years

- They can be used to help students in a class get to know each other.
- They can be used to help students see the relevance of course content to their own lives by demonstrating how many of their peers are affected by topics covered in a course.
- Clickers allow an instructor to collect response to such questions in such a way that students are not aware of the individual answers of their peers.

**Confidence Level Questions**

- It can be helpful to ask student how confident they are in their answers, following a true-or-false question.

- Dennis Jacobs, Chemistry, University of Notre Dame (page 105)
  o After a question, he often has students indicate their confidence – high, medium, or low – in their answers. This motivates them to think about and weigh arguments that might compete with the ones they use to answer his questions. Students in his course score points based on the accuracy of their answers and their confidence. It is in their best interest to rate their confidence accurately since they can earn extra credit from these questions.

<table>
<thead>
<tr>
<th>Confidence Level</th>
<th>Correct Answer</th>
<th>Incorrect Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>5 points</td>
<td>0 points</td>
</tr>
</tbody>
</table>
Another way to ask a confidence-level question is to ask students how confident they are that they could answer a particular content question, respond well to a particular essay question, or solve a particular problem were they asked to do so. This kind of question can be asked of more than just multiple-choice questions. These kinds of confidence-level questions can be useful in determining tasks for which students need assistance and can work very well at the start of a session designed to prepare students for an exam.

A fairly simple way to assess student’s confidence in their answers to content questions is to include an “I don’t know” option as an answer choice.

**Monitoring Questions**

- Monitor progress on a semester-long assignment such as a paper, project, or presentation.
- Ask students after the first or second assignment of the semester (a problem set, a short paper, a lab report) how long it took them to complete that assignment. This provides a sense of how difficult the assignment was – useful information to have when planning future assignments.
- Quiz students on various points made in the course syllabus throughout the semester in order to remind students of those points.
- Ask students prior to the first exam which of a set of possible study strategies is likely to be most effective in preparing for the exam.
- Ask the kinds of questions that frequently appear on end-of-semester course evaluation forms that students complete and asks them during the semester.
- Gather feedback on teaching styles.

**Classroom Experiments**

Example 3.15 – Derek Bruff, Mathematics, Vanderbilt University, based on Tversky and Kahneman (1982) (page 111)

- Bill is 34 years old. He is intelligent but unimaginative, compulsive, and generally lifeless. In school, he was strong in mathematics but weak in social studies and humanities. Rank the following statements in order of decreasing likelihood.
  - Bill is a physician who plays poker for a hobby
  - Bill is an architect
  - Bill is an accountant
  - Bill plays jazz for a hobby
  - Bill surfs for a hobby
  - Bill is a reporter
  - Bill is an accountant who plays jazz for a hobby
  - Bill climbs mountains for a hobby

Let A = “Bill is an accountant,” J = “Bill plays jazz for a hobby,” and AJ = “Bill is an accountant who plays jazz for a hobby.” Which of the following describes your ranking of these statements, where > means “more likely than”?

1. A > J > AJ
2. A > AJ > J
3. J > A > AJ
4. J > AJ > A
5. AJ > A > J
6. AJ > J > A
Chapter Four | Teaching Choices

Use of Class Time

- Given that having students respond to and discuss clicker questions takes class time, do instructors using clickers find it difficult to include as much content in their courses as they would without clickers?
  - Some instructors find it difficult to include as much content in their courses when they begin using clickers but are satisfied with the trade-off. They believe that if students’ misconceptions are not addressed, subsequent course material will not make sense to students, so class time spent resolving those misconceptions through clicker questions is well spent.
  - Other instructors are satisfied with covering less material because they believe that teaching methods that actively engage students with course material are more effective in the long term than less engaging methods that allow for more time-efficient coverage of content.
  - Barbara Reisner, who teaches chemistry at James Madison University, finds that by including clicker questions in class sessions, she is not always able to discuss all possible examples within each topic but can cover all the topics on her syllabus.
  - Other instructors find that including clicker questions and small-group and classwide discussions does not prevent them from including as many topics in their courses as they would without those activities.
  - Some instructors use online preclass reading quizzes to motivate students to prepare for class, while others use in-class reading quizzes facilitated by clickers.
  - Clicker questions need not displace portions of a lecture. Instead they can replace these portions.
  - Some instructors find that they can move more quickly during class because of the feedback and data-gathering capabilities of their classroom response systems.

- How much class time does a clicker question take? How many clicker questions should be used in a single class session?
  - Once a clicker question is posed, students typically begin answering it immediately. If students are able to decide on an answer quickly, the entire process of collecting responses and displaying results can take less than a minute.
  - The amount of class time a clicker question takes depends on what instructors have their students do prior to submitting their answers and on what instructors do once they have seen the results of a clicker question.
  - Teaching with a classroom response system can be somewhat unpredictable – it can take longer for students to respond to question that anticipated or the results are surprising. In these cases, instructors may find themselves spending more time on a question than planned.

Writing Questions

- Where can instructors find clicker questions for use in their courses?
  - Some textbooks come with question banks that contain questions written intentionally for in-class use with classroom response systems or for other purposes such as exams, which instructors can adapt for use as clicker questions.
  - Many instructors routinely ask free-response and rhetorical questions during class sessions, and often these questions can be turned into effective clicker questions.

- What are some strategies for constructing answer choice for clicker questions?
  - Creating answer choices for clicker questions that students will choose requires instructors to know what their students understand, what they do not understand, and the kinds of misconceptions and perspectives they have.
  - Examine student responses to free-response questions asked in other contexts.
  - Look to the homework problems. Cruce Atwood, Mathematics, Beloit College finds looking for potential clicker questions makes grading homework a little more enjoyable and productive.
  - Pose open-ended questions to students during class and solicit their thoughts on the question to be used later in the same course or in future courses.
• Have students respond to free-response questions before class, perhaps by e-mail or an online quiz.
• Have direct quotations from student responses to preclass free-response questions as answer choices.
• Pose free-response questions during class, have a few students volunteer possible answers to a question, then use the responses as answer choices for a clicker question. This method relies on having a classroom response system that enables instructors to pose clicker questions on the fly during class.

• How challenging should clicker questions be?
  o The difficulty of a clicker question is often shaped by the instructor’s learning goals for students, as well as the function of the question in the classroom.
  o Instructors using clicker questions to create times for telling or generate small-group or classwide discussion often find that more challenging questions engage students more in these processes.
  o A steady stream of challenging clicker questions can mentally exhaust some students. A few easy questions here and there can give students a break from more difficult questions and bolster their confidence by showing them what they know.

• Should instructors include answer choices such as “all of the above” and “none of the above”?
  o These questions typically take more time to implement during class since students must consider all of the answer choices.
  o These questions can be useful in challenging the students.
  o Example 4.1 – Mary Burke, Biological Sciences, Oregon State University (page 125)
    ▪ During energy generation, the product(s) of cyclic photosynthesis is (are):
      • A. ATP
      • B. oxygen
      • C. NADPH
      • D. hydrogen sulfide
    ▪ Here classroom response system displays the number of students who choose each of the possible combinations of answers. Burke uses PI with this question and finds that after the first vote, students select many different combinations, but there is usually at least one choice that appears in most of the combinations chosen by students.

• Should instructors include “I don’t know” as an answer?
  o Allows students who would otherwise guess randomly a chance to express their confusion about a question. However, it is not clear from a set of clicker results how confident students are in their answers.
  o Can potentially encourage students to take clicker questions less seriously.

• Must instructors prepare clicker questions before class? Can they ask on-the-fly questions during class?
  o Most classroom response systems have some capability to ask spontaneous questions during class.

• How can instructors improve their clicker questions?
  o Consider dropping or revising unpopular answer choices - those that are not chosen by many students.
  o Take notes on students’ comments in response to a clicker question. Constructing answer choices involves trying to predict how students might respond.
  o Share and discuss the clicker questions with colleagues interested in teaching, both in your own discipline and in other disciplines, with clickers.

Student Response, Participation, and Grading
• How do students respond to using classroom response systems? What do they typically appreciate about clickers? What do they not appreciate?
  o Many students appreciate the interactive element that a response system adds to a class.
  o Students appreciate that clickers allow them to respond anonymously to questions their instructors ask since this makes it safer for them to share opinions and otherwise participate in class.
  o If clickers are not used in ways that students perceive as beneficial to their learning, some may grumble.
Students who believe that an instructor is using clickers primarily or exclusively to enforce student attendance are likely to resent being tracked or monitored. If quizzes are not supplemented with other uses that more clearly benefit student learning, instructors are likely to encounter some student resistance.

One way to more clearly show the benefits for student learning is to review quizzes immediately after administering them.

If students are asked to purchase their own clickers, they often expect to use them regularly during class.

Example 4.2 – Which of the following reasons for using clickers in this class is most important to you? (page 134)

- A. Clickers allow me to check my understanding during class
- B. Clickers help my instructor focus attention on things we don’t understand
- C. Discussing clicker questions with other students helps me understand course content
- D. Clicker questions make class more lively and engaging

Sometimes those who readily understand material in a course dislike spending class time interacting with peers, particularly peers who do not seem to understand the course material as quickly or as well as they do.

Some students may resist clicker questions if they resist almost any attempt to engage them during class.

What problems do instructors using clickers encounter with students not bringing their clickers to class, not taking the process seriously, or cheating with clickers? How have instructors dealt with these problems?

- Students are more likely to remember to bring their clickers if the devices are used in every class session, if they are used in ways that seem integral to the learning experience, if they are used in their other courses, or if some portion of their grade depends on their use of clickers.
- Some instructors tell their students that if they forget their clickers or if their clickers are not working for some reason, such as a dead battery, then they can submit their answers to clicker questions on paper at the end of a class session.
- Another way to deal with the issue of forgotten or malfunctioning clickers is to allow students to drop some of their clicker grades.
- The issue of cheating arises when grades are assigned in some way based on students’ responses to clicker questions. Typically cheating takes for the form of student A giving his clicker to student B before class, student A skipping class, and student B responding to clicker questions with both his own clicker and student A’s clicker, making it appear that student A is present in class.
  - Being clear about anticheating policies and enforcing them when necessary seems to prevent much of this kind of behavior.

Should clicker questions be included as part of students’ grades?

- Clicker questions used as part of a quiz or exam are certainly graded.
- On occasions when instructors provide students the opportunity to answer questions completely anonymously, grading clicker questions is impossible.
- Assigning a grade to student responses to clicker questions tends to encourage students to bring their clickers to class and participate by answering questions.
- Robert Bartsch, Psychology, University of Houston at Clear Lake
  - His students do not purchase their own clickers. Instead, he brings a set of them to class every day. As a result, his clicker questions are completely anonymous. About 80 percent of his students respond to clicker questions in any given class session.
- Some instructors prefer to grade clicker questions on effort by assigning full credit for any answer submitted by students, regardless of the answer’s accuracy. This rewards students for participation.
- Other instructors prefer to grade clicker questions on accuracy by assigning full credit to correct answers and no credit to incorrect answers. This provides a strong incentive for students to participate and answer questions correctly.
- Other instructors prefer a mixed approach, assigning full credit to correct answers and partial credit to incorrect answers.
What are some effective grading schemes for clicker questions?

- Many instructors feel it is inappropriate to grade students on the correctness of their responses to clicker questions during the same class sessions in which the topics of those questions are introduced to the students.
- Grading clicker questions on accuracy can give students who correctly answer critical thinking questions the false sense that they have mastered those questions, when in fact it is often quite possible to answer such questions correctly without fully understanding all the reasons for and against the answer choices.
- Grading clicker questions on accuracy increases the pressure students feel to master course material. Some instructors want their students to feel this pressure, since it can motivate them to seriously engage with course material as it is being presented during class. Other dislike creating high-pressure classroom environments and prefer to grade clicker questions on effort, not accuracy.

- Mary Burke, Microbiology, Oregon State University (page 147)
  - She grades her in-class clicker questions on accuracy. She doesn’t want students to click just any answer, and grading clicker questions provides them the motivation to take the questions seriously. She asks questions on topics that have just been covered in lecture and since the students can consult their notes, she usually aims for at least ¾ of her students to answer the questions correctly.

- Linda Johnson, Nursing, University of South Carolina at Aiken (page 147)
  - She grades her clicker questions on accuracy. She typically asks four graded questions during each class period – two at the start that quiz on reading assignments and two at the end that assess students’ understanding of the lecture. Students score one point each for correct answers and no points for incorrect answers. These questions count for five percent of the students grades.

- Anthony Crider, Astronomy, Elon University (page 148)
  - He uses a mixed grading scheme. He assigns 10 percent of his students’ course grades to clicker questions. Each class period counts the same regardless of the number of questions asked. Students get half credit for incorrect answers and full credit for correct answers. Questions are drawn from readings, including lecture notes made available before class. Crider makes most of his clicker questions available to students before class.

- Instructors who grade clicker questions on effort also have the option of penalizing students who fail to reach a certain threshold of questions answered in a semester.

Classroom Choices

- How long should students be given to submit their answers to a clicker question? When should an instructor call time and end voting?
  - The amount of time to allow students to respond to a clicker question depends on the nature of the question.
  - Some instructors wait patiently until every student has responded to a question before closing the voting.
  - Other instructors wait until a certain percentage, 80 or 90 percent, respond and then announce to the class that voting will end in a few seconds.
  - Some instructors use the timer features common in classroom response systems which allow them to designate how many seconds or minutes are to be allowed per question. Instructors can decide before class how much time to allocate for each question. However, many response systems allows instructors to start the countdown at any point during the voting, so they have the option to wait until a certain percentage of students have replied and then begin the countdown.
  - One option for engaging fast responders is to walk over to the students and discuss the question at hand with them, asking them about the reasons they have for their answers and perhaps challenging those reasons in appropriate ways.
  - Another option is to encourage fast responders to discuss the question and their answers with each other if they have not already done so.
A third option is to give the fast responders a task that requires them to take another look at the question at hand, perhaps asking them to write down reasons that the answers they did not choose are incorrect.

- Should students be shown the results of a clicker question? Or should instructors view the results of a clicker questions without showing them to students?
  - If more than one answer choice is chosen by a significant number of students, then showing these results to students can demonstrate that the question is a challenging one and worth discussing further. Instructors often respond to results by having their students engage further with the question at hand, so it can be very helpful to show students these results.
  - If one of the answer choices is clearly more popular than the others an instructor might now want to show these results to the students.
  - Instructors who want to engage their students in further discussion of the question might now show them the results if there is clearly a more popular answer. Some students who believe they know the correct answer to a question are less likely to listen to or engage in any discussion.
  - If the question has a single correct answer and the popular answer is incorrect, then instructors likely want to have the students spend more time discussing it. If instructors reveal the results at this point, some students will assume that the popular answer is the correct one and be less inclined to engage in any discussion.

- For clicker questions with correct answers, at what point should instructors indicate which answer choice is correct?
  - Some instructors choose to indicate the correct answer to a clicker question immediately after the results are displayed to the students. It gives the students rapid feedback on their learning and can add a bit of dramatic flair to the display of the results.
  - When some students learn the correct answer to a clicker question they disengage with any subsequent discussion of the question, incorrectly assuming that they fully understand the question because they know the correct answer.
  - Instructors interested in using a clicker question to generate small-group or classwide discussion might prefer to delay revealing the correct answer until after discussions have had a chance to play out.
  - Instructors not as interested in generating discussion of a clicker question often use correct answer indicators.

Small Classes

- What advantages and challenges are there to using clickers in small courses?
  - Clickers allow all students to respond to question. They allow students to do so independently and, to a degree, anonymously, which can be useful when trying to generate discussion.
  - Small courses allow instructors to generate classroom environments that make it safer for students to share their perspectives, including those that involve minority viewpoints and potentially wrong answers, decreasing the need for providing students a way to respond anonymously.
  - In a small class, students are better able to guess which of their peers responded in particular ways to a clicker question based on the results displayed to the class.
  - There can be more pressure in smaller courses than in larger ones for students to provide answers to questions, particularly opinion questions, with which they think their instructor agrees even when those answers are not the students’ honest responses.
  - They can be used to help make participation grades more objective.

Chapter Five | Technical and Logistical Choices

Technical Challenges

- How often do technical problems prevent classroom responses from working? How can instructors deal with technical difficulties that arise in the classroom?
Instructors using a particular classroom response system for the first time should test the system as thoroughly as possible before using it with students.

Instructors may find it useful to use classroom response systems in fairly limited ways during the first few class sessions with a new system.

Students are more likely to weather technical difficulties well if their instructors remain calm and in control of the situation. Many instructors spend only a short time trying to troubleshoot a technical problem during class in an effort not to wasted limited class time. Have a backup plan in mind.

Some lower-tech options can be useful – hold fingers in front of chests or respond to questions in writing.

A clicker question intended for use in PI can still help generate discussion even if responses cannot be collected.

If only a few students have malfunctioning clickers, instructors with a few spare clickers or replacement batteries on hand can often help those students quickly.

- How much time does it typically take for an instructor to learn to use a classroom response system? How much time is required on a daily basis to prepare to use clickers in a class session?
  - This varies with the instructor’s computer experiences and the ease of use of the system in question.
  - Finding a colleague with experience using a certain feature can be critical in getting past problems. Sometimes contacting the system’s vendor’s technical support can be necessary.
  - In general, instructors interested in learning to use a classroom response system should give themselves at least a couple of weeks before they teach their first class in which they plan to use the system.
  - With some systems, inserting a few questions into an existing PowerPoint presentation takes only a minute or two per question.
  - Instructors who ask on-the-fly questions can prepare for class rather quickly.
  - Allocating points to the correct and incorrect answers belonging to each clicker question can take time before class.
  - Most instructors seem to take between ten and sixty extra minutes before class to prepare clicker questions for use in a classroom response system.

**Vendor Selection and Adoption**

- What are some important factors to consider when choosing a particular brand of classroom response system? (pages 165-176)
  - Cost Factors
    - Costs to students
    - Costs to institution
    - Does the vendor offer a discount to students or to the institution
    - Does the vendor partner with any textbooks
  - Hardware Factors
    - Clicker’s appearance – LCD, size, specialized batteries, etc.
    - Vendor’s receivers’ features – easy to set up, install permanently, number of clicker connections, etc.
    - Frequencies used to communicate between clickers and receivers
    - Warranties or return policies
  - Software Factors
    - Operating systems the software functions with
    - Software necessary on classroom computer
  - Accessibility
    - Ease of students with physical disabilities to use
  - Registration Methods
    - Register with local online course management system
    - Can students register clickers during class
Other registration methods provided
Fully anonymous use

Delivery Modes
- System integrate with PowerPoint or other presentation software
- Floating toolbar mode
- Ease to ask question on the fly
- Student-paced mode
- Homework mode
- Remote control management during class
- Options to monitor student responses

Question Types
- Choices permitted for multiple-choice questions
- True/False or Yes/No options
- Free-response questions
- Other types of questions

Result Displays
- Charts available to display results
- View individual student responses
- Display of results of two identical clicker questions on same chart
  - Figure 5.1 – Sample Bar Chart Showing Pre- and Posttest Results
- Display of results of two different clicker questions on same chart
- Display a list of students who respond first
- Display of results to free-response questions
- Display results submitted as being collected
- Display statistical summaries of student responses

  **Reporting and Grading Options**
  - Types of reports generated
  - Options for assigning point values to clicker questions
  - Internal gradebook for tracking and scoring responses
  - Upload grades from classroom response system to gradebook of online course management system
  - Facilitation of research into student responses

- Why might an academic unit (a department, college, school, or university) adopt a brand of classroom response system for use across that unit? What processes might the unit implement in order to select a brand? (pages 176-177)
  - Adoption of a single brand of clickers usually involves an agreement signed by the academic unit and the classroom response system vendor.
  - Adoption can provide additional savings to the academic unit or students.
  - Adoption can encourage more instructors to use clickers.
  - One disadvantage of adopting a single brand of clickers for use across an academic department is that instructors who prefer to use some other brand are less able to exercise that option.

**Supporting and Promoting the Use of Clickers**

- How can an instructor interested in using clickers for the first time get started?
  - Jump right in
    - Ask students in a particular course to purchase clickers at campus bookstore and committing to use the clickers throughout the course.
    - It can be useful for instructors new to teaching with clickers not to grade their students’ response to clicker questions on either effort or accuracy. This means that any problems that arise, technical or otherwise, do not affect student grades, so students will be less judgmental when problems occur.
    - Begin with fairly straightforward conceptual questions. Once an instructor is comfortable with the use of clickers, he/she might add a PI activity along with the questions.
    - Arrange with the bookstore to make clickers available.
  - Committing to use clickers but use clickers owned by their department or another department on campus
    - Advantage is that students do not spend money on IT of which the instructor is unsure.
    - This is limited by the availability of a classroom response system with as many clickers as there are students in the course.
    - Students need to pick up clickers on their way into a class session and return them at the end of class.
  - Borrow a set of clickers for just a few class sessions
    - This allows instructors to get a feel for the technology and see what kinds of questions and activities might work best in their teaching context.

- What are some ways of providing initial and ongoing support to instructors using clickers?
  - Connect instructors new to using clickers with experienced users.
  - Facilitate conversations among instructors about teaching with clickers.
  - Arrange for an instructor using clickers to hold an open house of sorts, inviting other instructors to visit his/her class for a day to see how clickers are used and to discuss those uses afterwards.
  - Working groups consisting of instructors who meet regularly to share and receive feedback on their clicker questions and activities or to read and discuss the literature on teaching and learning with clickers and other instructional technologies.
  - Provide instructors with easy access to support.
- Assist instructors in gathering useful feedback from their students.
- How might instructors who have used clickers successfully encourage their colleagues to try teaching with clickers?
  - Many campuses host workshops featuring instructors who share their experiences teaching with clickers.
  - Model the use of clickers at faculty meetings, faculty and teaching assistant orientations, and other events where instructors are present.
  - Invite a colleague to one’s class to see clickers in action.
  - Meet with an instructor before borrowing a set of clickers to discuss options for facilitating questions in the classroom and to meet with him/her afterward to discuss the experience.

**Low-Tech Options**
- What are some low-tech assessment methods that are similar to classroom response systems? What advantages do clickers have over these methods?
  - Hand-raising method
    - Fast way for instructors to gauge their students’ understanding or perspectives
    - Students can be hesitant to answer because it is not anonymous
  - Response cards
    - Color-coded cards
    - Dry erase boards
    - Can increase student participation since all students are asked to respond to a question
    - Can make it more difficult for students to know how their peers respond
    - The distribution of the responses is not visible to the students, limiting the impact of any communication of the results to the students
  - Choral response
    - An instructor poses a multiple-choice or free-response question and gives students time to think about and commit to their responses. Then students are instructed to state their responses verbally at the same time.
    - The simultaneous verbal nature of the responses can make it difficult for students to change their responses on learning their peers’ responses.
    - The difficulty of determining the distribution of responses with choral response limits its use in providing feedback.
  - Written responses
    - Have students write their answers to a multiple-choice or free-response question on slips of paper and pass those slips of paper to their instructor
    - It can take some time to collect and read student responses.
    - It can be difficult for instructors to get a sense of all their students’ responses, limiting its use in agile teaching.
    - It is perhaps most useful when instructors want to share with the class a random sample of student responses to free-response questions.

**High-Tech Options**
- How can student laptops be used as part of classroom response systems?
  - Software programs made available by response system vendors that can be installed on laptops to allow them to function as clickers.
  - Students might use the laptops for less productive purposes during class.
- How can student cell phones be used as part of classroom response systems?
  - Smart phones can sometimes run response system programs similar to those used on laptops, particularly ones that are Web based.
  - Have students text their responses to questions to an instructor’s or a teaching assistant’s cell phone.
Cell phones can allow students to respond more quickly to free-response questions that clickers often do. Individual students are more likely to have cell phones than laptops. Students can find cell phones even more distracting than laptops during class, particularly cell phones with the Internet connectivity or text-messaging capabilities necessary for their use as response devices.

Chapter Six | Why Use Clickers?

Increased Student Participation

- Clickers provide each student with a chance to respond to a question, including shy students who might not volunteer an answer verbally during class.
- Instructors can hold students accountable for their participation in class sessions, which also increases participation.
- Classroom response systems allow students to respond to questions without their peers knowing how they respond.

Increased Student Engagement

- They provide opportunity for independent thinking that engages students more fully with a question by encouraging students who might typically wait to hear their peers’ responses before seriously considering a question to think about a question on their own.
- Students are usually more engaged with a task when they are asked to produce a deliverable – an outcome, result, or product that demonstrates their learning.
- A student who responds to a clicker question makes a commitment to that answer. This commitment can motivate them to want to know if they answered the question correctly, to know their peers’ thoughts on the question, and to hear what their instructor has to say about it.

Frequent Feedback on Student Learning

- Clickers enable instructors to collect information on student learning from all students in a classroom quickly, easily, and simultaneously.
- The information on student learning provided by clickers can be used by instructors to modify their lesson plans during class to respond to immediate student learning needs.
- Formative assessment not only provides instructors with useful information about student learning, it also lets students know what they understand and do not understand.
- Missing a question motivates students to want to get the next one correct, so they are more engaged in the discussion.
- The use of a classroom response system can greatly increase the speed and efficiency with which instructors collect, grade, and record student performance on quizzes and tests.

Final Suggestions

- Consider the following questions when drafting clicker questions:
  - What student learning goals do I have for the question?
  - What do I hope to learn about my students by asking this question?
  - What will my students learn about each other when they see the results of this question?
  - How might this question be used to engage students with course content in small-group or classwide discussions or by creating a time for telling?
  - What distribution of response do I expect to see from my students?
  - What might I do if the actual distribution turns out very differently?
- Look for answer choices for potential clicker questions in student responses to open-ended questions, ones asked on assignments in previous courses, on homework questions, or during class. This can lead to answer choices that better match common student misconceptions and perspectives.
• Use a variety of types of clicker questions. Some courses lend themselves to particular types of questions but experimenting with different kinds of questions (application questions, critical thinking questions, student perspective questions, monitoring questions) can help instructors use clickers in ways that engage students and meet course learning goals.

• Experiment with asking on-the-fly clicker questions – ones that are not planned before class. Many classroom response systems make asking such questions possible. Often a classwide discussion leads to spontaneous clicker questions; other times rhetorical questions can be turned into productive clicker questions. Either way, asking such questions is one avenue for practicing agile teaching.

• Use clicker for purposes other than quizzes and taking attendance. Although clickers can make these activities more time efficient, students often prefer to see them used in ways that are more directly connected to their learning. Reviewing the results of a quiz immediately after administering it is one way to do so. Using clickers to engage students in small-group and classwide discussions and to offer students frequent feedback on their learning is also effective.

• Use clickers in smaller courses, particularly those that focus on sensitive or controversial topics. The anonymity that classroom response systems provide students can be important in helping them answer questions about tough topics honestly.

• Have students respond to clicker questions several times throughout a class session. Although questions at the beginning and end of class sessions can serve particular and useful functions, questions asked every ten to fifteen minutes can help focus students’ attention throughout the class.

• For some questions, have students think of their answers before showing them the answer choices. Since generating an answer is often more challenging than selecting an answer from a given set of possibilities, this can help make clicker questions more challenging. Also, hearing from students who generate answers not listed can help you learn about your students.

• Have students respond to a clicker question individually before discussing the question in small groups. This leverages a classroom response system’s ability to allow all students a chance to think about a question independently of their peers.

• Be strategic about showing students the results of a clicker question. If most students choose the same answer to a question with correct and incorrect answers, showing students such results might lead them to assume that the popular answer is the correct one and thus decrease their interest in discussing the question further. If students are split among more than one answer choice, however, showing students such results can help generate small-group and classwide discussions.

• For similar reasons, choose carefully when to indicate to students the correct answer to a clicker question. Once some students know the correct answer, they are likely to be less interested in further discussion of it, perhaps incorrectly assuming that knowing the answer means they understand the topic fully.

• When reviewing a clicker question with students, spend a least some time on each of the answer choices – right and wrong ones. Students often appreciate hearing their instructor’s perspective on the answer choices they selected, even when they know those choices are incorrect.

• When reviewing a clicker question with students, have them share their reasons for their answers. Not only does this shift students’ focus away from getting questions right or wrong and toward thinking critically, but it also provides useful insights into students’ thinking.

• When students find a question difficult, have them reengage with it through small-group or classwide discussion and then revote. Giving students multiple opportunities to answer a revote while providing them with feedback mechanisms along the way can help them make sense of course material.

• Immediately after class, take a few notes about how particular clicker questions played out during class. A little reflection right after class can help in refining and improving clicker questions over time.

• Find other instructors who teach with classroom response systems and share experiences. Too often teaching is a private act, one instructors do not discuss with their colleagues. However, such discussions are often very useful in helping instructors teach more effectively and more enjoyably.