i>clicker Best Practices

Suggestions on Using Clickers in the Classroom
This instruction set was developed by ITaP for instructor and student use.

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# i>clicker Best Practices

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Introduction

The authors quoted in this document have all extensively used clickers in the classroom.

Jane Caldwell is Clinical Assistant Professor of Biology at West Virginia University. Her article contains elements of her own personal observations as well as an extensive review of the clicker literature.

Mats Selen and Tim Stelzer are Professors of Physics at the University of Illinois and are two of the inventors of the i>clicker system.

Doug Duncan is a faculty member in the Department of Astrophysical and Planetary Sciences at the University of Colorado-Boulder, and Director of Fiske Planetarium.

David Bos is a Continuing Lecturer in the Department of Biological Sciences at Purdue University – West Lafayette. Mark Johnson is Manager of the Digital Design & Systems Labs and teaches in the School of Electrical and Computer Engineering, also at Purdue. Both have used clickers for several years.

Roberta Sullivan is an Instructional Designer and Teaching & Learning Consultant for the Teaching & Learning Center (TLC) for the University at Buffalo, State University of New York. Her role is to assist faculty to develop methods and strategies to help their students achieve desired learning objectives.

This article summarizes some of the most pertinent observations these authors have made regarding clicker use in the classroom. For more information, please see the Additional Resources section below.
Planning

Caldwell (2007):

- Know why you are using clickers in class, and keep this in mind while writing questions.
- Plan your grading system in advance. Make sure it aligns with your learning goals.
- Plan in advance for how to deal with students whose clickers are forgotten, need batteries, or are broken: Use slips of paper, have students trade ID cards for clickers, or keep some “loaner” clickers on hand. Discourage perpetual freeloaders.
- Before teaching your first course, watch another instructor who uses clickers.
- Be aware that the first year of use requires extra time to prepare good questions.
- Plan discussion time to respond to clicker question answers. Be willing to adapt your lesson plan according to the results you collect. Let students learn from the discussion of right and wrong answers. This is considered vital by most researchers in the field.
- Set up the system before class, and practice this before the semester begins.
- If your clickers require a registration system, test it in advance.
- If possible, find a resource person, train a teaching assistant, or start a faculty support group.
- Keep a positive attitude, and be willing to make a few mistakes as you learn. Consider this a chance to model the learning behavior you desire from your students.
- Consider building a library of clicker questions with colleagues, as too few of these exist in most fields.

Attendance

Caldwell (2007):

- If you want to increase attendance, use clickers daily and link clicker usage to grades.
- Use clickers especially with introductory courses for freshmen to encourage attendance and accountability and to reduce attrition.
- If you are requiring attendance, expect an increase in classroom noise and possibly some disengaged students who are attending only for points.

Setting Student Expectations

Caldwell (2007):

- Explain to students why you are using the system and what you expect students to gain from the experience in order to get them to support the idea, especially if you are using it for nontraditional activities like active learning.
- Explain to students the purpose of homework, and use clickers to hold them accountable.
- Discuss cheating with students, and clearly state that use of another student's clicker is unacceptable. In a survey, between 20 and 58% of students reported seeing a classmate cheat by using multiple clickers at some point during the semester.

Bos & Johnson (2011):

- Students caught using more than one clicker in class – confiscate both clickers, and sanction both students.
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Classroom Technique

Caldwell (2007):

• If incorporating a class wide discussion into your clicker use, be sure to summarize the discussion and explain the correct answer afterward.
• Expect that a few students will intentionally press the wrong button, cast misleading votes, or delay voting to consume class time.
• Encourage students to discuss answers with each other. These increases peer learning and will eliminate one type of “cheating.”
• Encourage class discussion of incorrect answers to reveal unclear wording; this can be especially important if you notice dramatic improvement in scores after peer discussion.

Selen & Stelzer (2008):

• Use the clickers consistently, beginning with your first lecture. With infrequent or irregular use, students may resent having to purchase the devices and will forget to bring them to class. Although the optimal number of questions varies with your class, topic, and pedagogical goals, posing 3–5 questions in an hour is a reasonable guideline.
• Don’t be reluctant to ask “on-the-fly” questions as they occur to you or to your students. Students appreciate spontaneity (perhaps because it lets them know you’re attuned to their specific needs).

Duncan (2008):

• Make clicker use a regular, serious part of your course. If you treat clicker use as unimportant or auxiliary then your students will too.
• If you are a first-time clicker user, start with just one or two questions per class. Increase your use as you become more comfortable.

Bos & Johnson (2011):

• Start each class with a quiz on the readings for that day.
• Use only difficult questions. This will serve as a wakeup call and encourage study.
• Do not show histograms during polling of graded questions, because many students wait to see the answer trends and will gravitate to the most popular choice whether they have thought the question through or not.
• Use clickers in anonymous mode during class discussion of controversial issues. Clickers can democratize – the loudest voices find it more difficult to control the class.
• Occasionally, leave a question open for a long time and ask students to continually indicate their understanding. Watching a histogram change dynamically can stimulate class discussion [this technique is not suitable for graded questions].
• Immediately after giving a paper quiz, give the same quiz with clickers and discuss the answers. This can be a helpful learning tool!
• Don’t use clickers only for academic uses. Also use them to discuss course administration issues, gauge the degree of completion of projects, etc.
Alleviating Student Anxiety

Caldwell (2007):

- If clicker scores are part of the course grade, make those scores accessible on a regular basis to reduce student anxiety. Consider showing students clicker scores from past semesters on the first day of class.
- Give partial credit for any answer and full credit for correct answers to reduce anxiety and limit cheating. Consider dropping a few of the lowest clicker scores or selecting a portion of data at random.
- Spend some time in the first classes training students to use clickers.
- Allow a few days for students to buy and/or register clickers. Be aware that in some cases, 5–10% of students never purchased or registered their clickers.

Duncan (2008):

- You MUST MUST MUST explain to students why you are using clickers. If you don’t, they often assume your goal is to track them like Big Brother, and force them to come to class. Students highly resent this.

Question Writing

Bos & Johnson (2011):

- Use questions from old exams. An advantage is that you have experience with your old questions and will need less time to prepare explanations for them.

Caldwell (2007):

“Examples of good questions include presenting a new concept and asking which ideas (or categories) it is most closely related to, showing an example of a new concept, or applying a mastered concept to a new situation.

“Generally speaking, qualitative questions (that avoid calculations, memorization, or facts) are favored because they guide the student to focus on the concept without becoming distracted by details.”

Some principles:

- Good clicker questions should address a specific learning goal, content goal, skill, or reinforce a specific belief about learning
- Questions can:
  - assess students’ background, knowledge, or beliefs
  - make students aware of others’ views or of their own
  - locate misconceptions and confusion
  - distinguish between related ideas
  - show parallels or connections between ideas
  - explore or apply ideas in a new context

Some examples of questions recommended by the literature include:
• given a term or concept, identify the correct definition from a list, and vice versa
• given a graph, match it with the best description or interpretation, and vice versa
• match a method of analysis with an appropriate data set, and vice versa
• questions that link the general to the specific
• questions that share a familiar situation or example with several other questions
• questions that students cannot answer, to motivate discussion and curiosity before introducing a new topic
• questions that require ideas or steps to be sorted into order
• questions that list steps and ask “which one is wrong?”
• questions that apply a familiar idea to a new context.

“Several researchers assert that it is useful, and even important, to design questions that produce a wide set of responses or on which some portion of the class makes mistakes.... Others seem to agree, asserting that exploring those misconceptions can be an important part of steering students toward deeper understanding, not just factual knowledge.... To construct such questions, it is helpful to:

• identify student misconceptions and include them as answers, plausibly phrased
• “shut up and listen” to students to find out how they think, and pay particular attention to wrong answers
• include answers that contain common errors”

Practical questioning techniques include:

• limit the number of answers to five or less, so that question is easy to read and consider
• assess knowledge of jargon separately from concepts to ensure that each is addressed clearly and effectively
• create wrong answers (distractors) that seem logical or plausible to prevent “strategizing” students from easily eliminating wrong answers
• include “I don’t know” as an answer choice to prevent guessing
• Plan to ask some questions twice to allow peer learning and build emotional investment. (Allow students to answer individually, but do not display the correct answer; then direct students to discuss the question with their peers and answer again.) This approach is advocated by many instructors who have used clickers.

**Sullivan (2009):**

“The development of effective questions determines the outcome of whether or not the use of a classroom response system is a useful teaching tool. At first impression, one might think that having students respond to multiple-choice questions inspires a rote-learning environment. If instructors take the time and put forth effort to fully consider the best ways to implement clicker driven questions that target higher levels of learning, then classroom response systems can become a very effective learning tool.”

“Beatty, Gerace, Leonard, and Dufresne (2006) accurately advise that learning to operate the technology is the easiest part of mastering clicker-based instruction. Question development is by far the most critical and difficult aspect of integrating clickers into your teaching repertoire.”

“...‘good’ clicker questions are different from a written test and quiz questions...the numerous test banks provided by textbook publishers are often not suitable questions for clicker usage. However,
many of the principles that apply to developing good multiple-choice questions are valid in relation to the development of good clicker questions.”

Sullivan offers the following guidelines for multiple-choice question writing, developed through a review of an authoritative textbook by Haladyna, Downing, and Rodriguez (2002) (those marked with an asterisk are cited more often in the literature, implying that they are of higher importance):

**Content concerns**

1. Every item should reflect specific content and a single specific mental behavior, as called for in test specifications (two-way grid, test blueprint)
2. Base each item on important content to learn; avoid trivial content
3. Use novel material to test higher level learning. Paraphrase textbook language or language used during instruction when used in a test item to avoid testing for simple recall*
4. Keep the content of each item independent from content of other items on the test
5. Avoid over specific and over general content when writing MC items
6. Avoid opinion-based items
7. Avoid trick items
8. Keep vocabulary simple for the group of students being tested

**Formatting concerns**

9. Use the question, completion, and best answer versions of the conventional MC, the alternate choice, true-false (TF), multiple true-false (MTF), matching, and the context-dependent item and item set formats, but AVOID the complex MC (Type K) format*
10. Format the item vertically instead of horizontally

**Style concerns**

11. Edit and proof items
12. Use correct grammar, punctuation, capitalization, and spelling
13. Minimize the amount of reading in each item

**Writing the stem**

14. Ensure that the directions in the stem are very clear*
15. Include the central idea in the stem instead of the choices*
16. Avoid window dressing (excessive verbiage)
17. Word the stem positively, avoid negatives such as NOT or EXCEPT. If negative words are used, use the word cautiously and always ensure that the word appears capitalized and boldface*

**Writing the choices**

18. Develop as many effective choices as you can, but research suggests three is adequate
19. Make sure that only one of these choices is the right answer*
20. Vary the location of the right answer according to the number of choices
21. Place choices in logical or numerical order
22. Keep choices independent; choices should not be overlapping
23. Keep choices homogeneous in content and grammatical structure
24. Keep the length of choices about equal*
25. “None-of-the-above” should be used carefully*
26. Avoid “All-of-the-above”*
27. Phrase choices positively; avoid negatives such as NOT
28. Avoid giving clues to the right answer, such as*
   a. Specific determiners including always, never, completely, and absolutely
   b. “Clang Associations,” choices identical to or resembling words in the stem
   c. Grammatical inconsistencies that clue the test-taker to the correct choice
   d. Conspicuous correct choice
   e. Pairs or triplets of options that clue the test-taker to the correct choice
   f. Blatantly absurd, ridiculous options
29. Make all distractors plausible*
30. Use typical errors of students to write your distractors
31. Use humor if it is compatible with the teacher and the learning environment

Sullivan notes “Many of the multiple-choice item-writing guidelines listed previously apply generally to a variety of questions. It should be noted that some of the guidelines do not apply to questions used in conjunction with classroom response systems. An example of one of these exceptions [which applies to item 6] is that classroom response systems are very well suited to draw out student opinions. Since students’ responses [can be] anonymous, clickers are helpful to get students’ opinions about controversial topics to stimulate discussion and debate. This technique, which causes students to become engaged in the course content, is well suited to...peer [learning]....”

## Grading

### Caldwell (2007):
- Be willing to throw out or re-grade a question that contains an error or is unclear.

### Selen & Stelzer (2008):
- Choose a grading scheme that is both consistent with your objectives and easy to manage.
- Don’t assign too many points for clicker questions. Even 5% of the final course grade is enough to motivate students to participate without causing too much stress in class.
- Assign points for both participation (which improves attendance) and for getting the correct answer (which encourages students to take the questions more seriously).
- Drop the 3 lowest clicker scores, so students aren’t penalized for missing a few classes or forgetting their clickers a few times. It also minimizes...having to deal with student excuses, extra e-mails, missing grades, administering “loaners,” etc.
- Keep your grade book up to date. This encourages students to get their clickers registered quickly, provides an ongoing formative assessment of their understanding of course material, and assures them they’re getting the appropriate credit for their participation. It also allows you to contact students who aren’t getting credit so the issue can be resolved early on in the term.

### Bos & Johnson (2011):
- Participation points – ask questions twice. The first time, give one point for participation. The second time, grade the question. If you only give points for participation, students will answer randomly to get participation credit without thinking about the question, thus negating any learning effect.
- To discourage cheating, keep clicker use low stakes, forming only about three percent of the course grade.
Peer Learning

Caldwell (2007):

Caldwell notes that “peer learning and other active learning methods have been demonstrated to result in higher learning gains and/or exam scores than more traditional, content-based approaches to course material such as lecture...The strength of peer instruction is the interaction it fosters between students, who by virtue of their similar ages, language, and common experience, are often better at clearing up each other's confusions and misconceptions than their instructor”

There are two basic methods to peer instruction:

1. Ask the question, go immediately into small-group discussion, then answer the question and display the answers
2. Ask the question, have students think and answer independently first and display the answers, then spend time in groups followed by a second polling of the question

Caldwell notes “Some data indicate that the [second] method works better in larger classes, because individual answers force stronger engagement, and the class discussion portion of [the first method] may introduce too much confusion, unless the question asked is very difficult.... In practice, a careful combination of the two methods by an observant instructor may be best.”

Caldwell says that if using peer learning groups, limit group size to no more than four to six members. Students seem to prefer small-group discussions to class wide discussions led by the instructor

Selen & Stelzer (2008):

When doing Peer Learning:

• Be sure to allow sufficient time, especially for the more difficult problems. The discussion itself can be a key part of your students’ learning process, and they can become frustrated if they don’t have enough time to think about the question and their answer.

• Also, as students engage in these discussions, walk around the room and listen to (or even join) the dialogue. This is a great way to learn how and what your students are thinking, and how you should proceed with the particular topic.

Duncan (2008):

• Explain that it is the discussion itself that produces learning and if they “click in” without participating they will probably get a lower grade on exams than the students who are more active in discussion.

• The best questions for peer discussion are ones that around 30-70% of students can answer correctly before discussion with peers. This maximizes good discussion and learning. There is value in discussion even if a question is difficult and few know the answer initially.
What NOT To Do

Duncan (2008):
Seven practices that lead to failure
1. Fail to explain why you are using clickers
2. Use them primarily for attendance
3. Don’t have students talk with each other
4. Use only factual recall questions
5. Don’t make use of the student response information
6. Fail to discuss what learning means or the depth of participation and learning you expect in your class
7. Think of clickers as a testing device, rather than a device to inform learning

Additional Resources

Tips from i>clicker users
A resource on the i>clicker web site that features many excellent suggestions sent in from i>clicker users.
http://www.iclicker.com/community/bestpractices/#TOP

Clicker Resource Guide
A comprehensive guide prepared by staff from the University of Colorado-Boulder Science Education Initiative and the University of British Columbia Carl Wieman Science Education Initiative. It contains a wealth of ideas and pedagogical FAQs.
http://www.iclicker.com/uploadedFiles/Clicker_guide_CWSEI_CU-SEI.pdf

Blog: Teaching with Classroom Response Systems
Created by Derek Bruff, author of Teaching with Classroom Response Systems: Creating Active Learning Environments.
http://derekbruff.com/teachingwithcrs/

Case Studies
Detailed case studies of implementing and using i>clicker in courses in specific fields of study. Very valuable for finding information specific to using i>clicker for teaching in your discipline.
http://www.iclicker.com/community/casestudies/

Best Practices
From the University of Wisconsin-Milwaukee:
http://www4.uwm.edu/ltc/srs/faculty/best_practices.cfm

Literature Review
i>clicker-assembled list of clicker literature. i>clicker’s disclaimer says “None of the below web resources were created by or for i>clicker or are affiliated with i>clicker in any way.”
http://www.iclicker.com/community/research/

**Faculty Syllabi**

Examples of faculty syllabi that indicate how instructors have integrated clickers into their courses. From the University of Wisconsin-Milwaukee.
http://www4.uwm.edu/ltc/srs/faculty/showcase_use.cfm

**References**

Bos, D. H. & Johnson, M. (2011, October). i>Clicker Training. ITaP training session presented at Purdue University, West Lafayette, IN.


