**Classroom Response Systems
*by Derek Bruff***

Welcome to the Center for Teaching’s introduction to teaching with classroom response systems (“clickers”). On this page you’ll find strategies for using clickers in your teaching, as well as logistical information on using clickers with your courses at Vanderbilt. For a more complete treatment of the former, see my book, [*Teaching with Classroom Response Systems: Creating Active Learning Environments*](http://www.amazon.com/gp/product/0470288930?ie=UTF8&tag=teachwithclas-20&linkCode=as2&camp=1789&creative=9325&creativeASIN=0470288930), available in the [CFT library](https://cft.vanderbilt.edu/library/). I also [blog regularly](http://derekbruff.org/?cat=122) about classroom response systems on my personal blog, [Agile Learning](http://derekbruff.org/).

**What Is a CRS?**

A classroom response system (sometimes called a personal response system, student response system, or audience response system) is a set of hardware and software that facilitates teaching activities such as the following.

* **A teacher poses a multiple-choice question to his or her students** via an overhead or computer projector.
* **Each student submits an answer to the question using a handheld transmitter (a “clicker”)** that beams a radio-frequency signal to a receiver attached to the teacher’s computer.
* **Software on the teacher’s computer collects the students’ answers and produces a bar chart** showing how many students chose each of the answer choices.
* **The teacher makes “on the fly” instructional choices in response to the bar chart** by, for example, leading students in a discussion of the merits of each answer choice or asking students to discuss the question in small groups.

**Videos**

* [Clickers in Action](http://www.youtube.com/watch?v=CnnP0uCqD4k&feature=email) – In this short video, Russell James from the University of Georgia explains how he uses clickers in the classroom.

**Terminology**

The Vanderbilt Center for Teaching has decided to use the term “classroom response system” to describe this technology. The term “audience response system” is another popular term, but some faculty see that term as implying that students are passive members of an audience, which runs counter to their use of this technology in getting students actively engaged with course material during class. The term “personal response system” is also popular, but we have decided not to use it, since it happens to be the brand name of a particular vendor’s system. “Student response system” is also a useful term, but it doesn’t highlight the use of these systems in the classroom and could refer to an online response system of some kind.

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| “Professor Ross Cheit put it to the students in his Ethics and Public Policy class at Brown University: Are you morally obliged to report cheating if you know about it? The room began to hum, but no one so much as raised a hand.“Still, within 90 seconds, Cheit had roughly 150 student responses displayed on an overhead screen, plotted as a multicolored bar graph — 64 percent said yes, 35 percent, no.”— ["No Wrong Answer: Click It," Associated Press, May 14, 2005.](https://www.wired.com/2005/05/no-wrong-answer-click-it/) |

**Teaching with a CRS**

**Types of Questions**

Many instructors see multiple-choice questions as limited to testing students’ recall of facts. However, multiple-choice clicker questions can actually serve many other purposes in the class, including assessing students’ higher-order thinking skills. Since clicker questions can be used not only to assess students but to engage them, some very effective clicker questions are quite different than multiple-choice questions that might appear on exams.

Here are a few types of clicker questions.

* **Recall Questions:** These questions ask students to recall facts, concepts, or techniques relevant to class. They are often used to see if students did the reading, remember important points from prior classes, or have memorized key facts. They rarely generate discussion, however, and don’t require higher-order thinking skills.
* **Conceptual Understanding Questions:** These questions go beyond recall and assess students’ understanding of important concepts. Answer choices to these questions are often based on common student misconceptions, and so these questions work well to help instructors identify and address their students’ misconceptions. Questions asking students to classify examples, match characteristics with concepts, select the best explanation for a concept, or translate among different ways of representing an idea are examples of conceptual understanding questions.
* **Application Questions:** These questions require students to apply their knowledge and understanding to particular situations and contexts. Application questions often ask students to make a decision or choice in a given scenario, connect course content to “real-world” situations, implement procedures or techniques, or predict the outcome of experiments or even their peers’ response to a subsequent question.
* **Critical Thinking Questions:** These questions operate at the higher levels of [Bloom’s Taxonomy](https://cft.vanderbilt.edu/teaching-guides/pedagogical/blooms-taxonomy/), requiring students to analyze relationships among multiple concepts or make evaluations based on particular criteria. Often these questions are “one-best-answer questions,” questions that include multiple answer choices that have merit. Students are asked to select the one best answer from these choices. One-best-answer questions aren’t appropriate for exams, since the reasons students provide for or against answer choices are of more interest than their particular answer selections. However, these questions can be very effective in preparing students to engage in class discussions about their reasons.
* **Student Perspective Questions:** These are questions that ask students to share their opinions, experiences, or demographic information. These questions do not have correct answers, but by surfacing the various perspectives of students in a class, they can help both instructors and students better understand those perspectives. They can often generate rich discussion, particularly questions about ethical, legal, or moral issues. They can also help students connect their personal experiences to more abstract course content. The anonymity that clickers provide is often an essential ingredient in asking these kinds of questions.
* **Confidence Level Questions:** Asking students a content question, then following that by asking students to rate their confidence in their answers (high, medium, or low) can enhance the usefulness of information on student learning provided by the first question. Prompting students to assess their confidence can also aid in metacognition–learning about one’s own learning. Instructors can also ask “predictive” confidence level questions by asking students how confident they are that they could correctly answer some question or accomplish some task in which they have not yet engaged.
* **Monitoring Questions:** These are questions designed to provide instructors with information about how their students are approaching the learning process in their courses. For instance, one week before a paper assignment is due, instructors might ask students whether or not they have completed rough drafts as a way to gauge their progress. Asking students how long they took to complete an assignment they have just turned in can provide instructors with useful information about the difficulty of the assignment. Clicker questions can also be used to see if students remember good advice or course policies shared on a first-day-of-class course syllabus. The questions that appear on end-of-semester course evaluations also make useful monitoring questions at the midpoint of the semester.
* **Classroom Experiments:** Classroom response systems can also be used to collect data from students for classroom experiments often used in the social sciences. Often data generated by students during class can be used to make points about social behavior. By allowing these data to be collected and analyzed during class, clickers can bring a sense of immediacy and relevance to these kinds of experiments.

**Types of Activities**

Teaching with a CRS can take a number of directions. Teachers will want to match activities to course content, time constraints, learning objectives, and their own teaching styles. Some possibilities for CRS activities include the following, listed more or less in order of increasing levels of student engagement.

* **Attendance:** Clickers can be used to take attendance directly (e.g. asking students to respond to the question “Are you here today?”) or indirectly by determining which students used their clickers during class.
* **Summative Assessment:** Clickers can be used for graded activities, such as multiple-choice quizzes or even tests. Some brands of clickers allow for a “student-paced” mode in which students answer questions on a printed test at their own pace.
* **Formative Assessment:** Clickers can be used to pose questions to students and collect their answers for the purpose of providing real-time information about student learning to both the instructor and the students. Students can use this feedback to monitor their own learning, and instructors can use it to change how they manage class “on the fly” in response to student learning needs. Some brands of clickers allow students to register their confidence level (high, medium, or low) along with their answer, providing more detailed feedback to the instructor.Some instructors assign participation grades to these kinds of formative assessments to encourage students to participate. Other instructors assign points for correct answers to encourage students to take these questions more seriously. Other instructors do a mix of both, assigning partial credit for wrong answers.
* **Homework Collection:** Some brands of clickers allow students to record their answers to multiple-choice or free response homework questions outside of class and submit their answers via the clickers at the start of class.
* **Discussion Warm-Up:** Posing a question, giving students time to think about it and record their answers via clickers, and then displaying the results can be an effective way to warm a class up for a class-wide discussion. Compared with the approach of taking the first hand that is raised after a question is asked, this approach gives all students time to think about and commit to an answer, setting the stage for greater discussion participation.
* **Contingent Teaching:** Since it can occasionally be challenging to determine what students understand and what they do not understand, clickers can be used to gauge that in real-time during class and modify one’s lesson plan accordingly. If the clicker data show that students understand a given topic, then the instructor can move on to the next one. If not, then more time can be spent on the topic, perhaps involving more lecture, class discussion, or another clicker question.This approach has been called “agile teaching” by [Beatty et al. (2006)](https://cft.vanderbilt.edu/docs/classroom-response-system-clickers-bibliography/), who write, “This contrasts with the common practice of teaching according to a ‘ballistic’ lesson plan: designing a plan for an entire class meeting, ‘launching’ the plan, hoping that it hits reasonably close to its target, and waiting for the next exam to know for certain.” Certainly there are other ways to determine if students are understanding course material as one progresses through a course, but clickers can provide a convenient way of doing so. See also [Draper & Brown (2004)](https://cft.vanderbilt.edu/docs/classroom-response-system-clickers-bibliography/) for more on this approach.
* **Peer Instruction**: The teacher poses a question to his or her students. The students ponder the question silently and transmit their individual answers using the clickers. The teacher checks the histogram of student responses. If significant numbers of students choose the wrong answer, the teacher instructs the students to discuss the question with their neighbor. After a few minutes of discussion, the students submit their answers again. This technique often (but not always!) results in more students choosing the correct answer as a result of the peer instruction phase of the activity. This is a fairly simple way to use clickers to engage a large number of students in discussions about course material. This approach can also set the stage for a class-wide discussion that more fully engages all students. See [Mazur (1997)](https://cft.vanderbilt.edu/docs/classroom-response-system-clickers-bibliography/) for more on this approach.
* **Repeated Questions:** In the peer instruction approach described above, students respond to a given question twice–once after thinking about their answer individually and again after discussing it with their neighbor. Some instructors ask the same question several times, with different activities in between rounds of voting designed to help students better answer the question. For instance, an instructor might have the students answer the question individually, then discuss it with their neighbor and respond, then participate in a class-wide discussion and respond, and then listen to a mini-lecture on the topic and respond. For particularly challenging questions, this can be an effective technique for helping students discover and explore course material.
* **Question-Driven Instruction:** This approach combines contingent teaching and peer instruction. Lesson plans consist entirely of clicker questions. Which questions are asked depends entirely on how students answer the questions. An instructor might come into class with a stack of clicker questions, with multiple questions on each topic. As students perform well on clicker questions, the instructor moves on to questions on new topics. As students perform poorly, the instructor asks further questions on the same topic. The instructor does not have a lesson plan in the traditional sense when using this approach. Instead, the course of the class is determined reactively to demonstrated student learning needs. See [Beatty et al. (2006)](https://cft.vanderbilt.edu/docs/classroom-response-system-clickers-bibliography/) for more on this approach.
* **“Choose Your Own Adventure” Classes:** In this technique, an instructor poses a problem along with several possible approaches to solving it–perhaps approaches suggested by students during class. The instructor has the students vote on which approach to pursue first, then explores that approach with the students. Afterwards, the students vote on which approach to pursue next. See [Hinde and Hunt (2006)](https://cft.vanderbilt.edu/docs/classroom-response-system-clickers-bibliography/) for an example of this approach.

**Examples**

* [**Economics**](https://cft.vanderbilt.edu/2007/12/episode-2-an-interview-with-steve-buckles/) In [this podcast interview](https://cft.vanderbilt.edu/2007/12/episode-2-an-interview-with-steve-buckles/), Stephen Buckles, senior lecturer in economics here at Vanderbilt University, describes his use of a classroom response system in his large undergraduate courses.
* [**Mathematics** Project Math QUEST](http://mathquest.carroll.edu/) is a project funded by the National Science Foundation to write and test clicker questions for use in linear algebra and differential equations courses. Their questions are available online, and their [resource page](http://mathquest.carroll.edu/resources.html) contains links to other question banks in the field of mathematics.
* [**General Physics**](http://www.vanderbilt.edu/cft/resources/teaching_resources/technology/crs_hutson.ppt) (PowerPoint) Shane Hutson, Assistant Professor of Physics and Astronomy at Vanderbilt, describes his use of the H-ITT classroom response system in a general physics course in this PowerPoint file. He used a CRS for **ConcepTests** (checks of student understanding during lectures), **interactive demos** (having students guess the results of a physics demonstration immediately before the demo), and **reading quizzes** (graded assignments designed to see if students did their readings before class).
* [**Architectural Engineering**](http://www.ph.utexas.edu/~ctalk/bulletin/intice.htm) The Interactive Technology to Improve the Classroom Experience (INTICE) project at the College of Engineering at the University of Texas at Austin evaluated the use of a CRS in one of their architectural engineering core classes. Their report, available at the above link, provides **example questions** and details their **evaluation of the CRS as a learning tool**.

**Why Use a CRS?**

A teacher can use a CRS to…

* …**Maintain students’ attention during a lecture**. Studies show that most people’s attention lapses after 10 to 18 minutes of passive listening. Inserting a few CRS-facilitated activities every so often during a lecture can help maintain students’ attention. See [The “Change-up” in Lectures](http://www.indiana.edu/~teaching/allabout/pubs/changeups.shtml) for more on this idea.
* …**Promote active student engagement during a lecture**. Posing well-chosen questions to students during lecture and expecting answers from each student can cause students to reflect on and assimilate course content during class.
* …**Promote discussion and collaboration among students during class** with group exercises that require students to discuss and come to a consensus.
* …**Encourage participation from each and every student in a class**. Asking a question verbally and calling on the first student to raise his or her hand results in one student participating. A CRS-facilitated activity can involve not one, but all of the students in the class.
* …**Create a safe space for shy and unsure students to participate in class**. A CRS gives students a chance to respond to a teacher’s question silently and privately, enabling student who might not typically speak up in class to express their thoughts and opinions. A CRS also enables students to respond anonymously to sensitive ethical, legal, and moral questions.
* …**Check for student understanding during class**. By asking CRS-facilitated questions, teachers can determine if students understand important points or distinctions raised in class. They need not wait until homework is turned in or exams are completed to do so. Instead they can receive feedback on a lecture during that same lecture.
* …**Teach in a way that adapts to the immediate learning needs of his or her students**. If a histogram of student answers shows that a significant number of students chose wrong answers to a question, then the teacher can revisit or clarify the points he or she just made in class. If a histogram shows that most students chose the correct answers to a question, then the teacher can move on to another topic.
* …**Take attendance and to rapidly grade in-class quizzes**, provided that each transmitter is assigned to a unique student over the length of a course. Note that different CRS systems provide different levels of support for anonymous and non-anonymous usage.
* …**Add a little drama to class**. There is often a sense of expectation as wait for the histogram to appear showing how their classmates answered a given question.

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| “Putting up your hand in class is pretty complex thing, kind of dangerous, socially and academically. But everyone is willing to give anonymous answers. Everyone is equally involved and the answers are honest. And fast.”— [Victor Edmonds, Educational Technology Services, University of California at Berkeley](http://campustechnology.com/articles/38434_3/) |

For more on reasons to use a CRS, see our [bibliography of scholarly articles on the effectiveness of CRS](https://cft.vanderbilt.edu/docs/classroom-response-system-clickers-bibliography/), organized by discipline.

**Challenges in Using a CRS**

While a CRS can facilitate a variety of student-active teaching activities, a teacher using a CRS should be aware of the following challenges.

* As with any use of computer technology in the classroom, **technical problems can arise**. A teacher using a CRS should allow time at the beginning of class to set-up and troubleshoot the CRS. Also, non-CRS back-up activities should be planned in the event of a total CRS failure.
* **Getting started with a CRS takes some time.** Current systems are easier to learn and use than older systems, but there is still some start-up time required. Having an experienced user around is helpful.Adapting lesson plans to take advantage of clickers takes time, too. However, it is often not hard to start small by adding a question or two to each class, particularly if the instructor has a good idea where students are likely to have difficulties.
* Most CRS technology restricts teachers to posing multiple-choice questions, and **writing effective multiple-choice questions can be challenging**. Knowledge of common student mistakes and misconceptions can be useful in designing wrong answers to multiple-choice questions. Asking students open-ended questions and then adapting their responses into later multiple-choice questions can also be effective. Some instructors take student suggestions for answer choices during class. Others take advantage of existing banks of questions in their disciplines.
For advice on writing multiple-choice questions, see [*Constructing Written Test Questions for the Basic and Clinical Sciences*](http://www.nbme.org/PDF/ItemWriting_2003/2003IWGwhole.pdf)*,* a National Board of Medical Examiners booklet on writing effective test questions with advice on true-false questions, one-best-answer questions, extended matching questions, and avoiding “testwiseness” and irrelevant difficulty in questions.
* **Using a CRS in class takes up class time**. If students do not keep possession of transmitters between classes, some time will be spent at the beginning of class distributing the transmitters. Moreover, a few minutes will be needed for students to transmit their answers, and class time will be used discussing student responses.Some teachers have responded to this challenge by relying on pre-class reading assignments to convey portions of course material. Others use the time limit function of a CRS (where students are given only so much time to respond to a given question) to help manage class time. Others feel that students need to master certain material before moving on, and using clickers to ensure that mastery is worth the extra time. Others feel that using clickers to get feedback on student understanding actually allows them to progress through material more quickly by determining what topics they can safely omit.
* The wrong answers that students choose in response to a multiple-choice question can reveal that the students have misconceptions, but **knowing that students have misconceptions does not necessarily reveal what those misconceptions are**. Teachers using CRS questions sometimes find it surprising when large numbers of students choose certain wrong answers, and further classroom discussion is sometimes needed to explore why students chose the wrong answers they did.
* When a teacher uses a CRS to check for student understanding during class, if it turns out the students do not understanding a particular concept or application, then **the teacher may have to change his or her lesson plan “on the fly.”** This can be challenging for teachers who are used to preparing their lessons thoroughly in advance or who do not think on their feet as well as some. Instructors often must decide when to move on to the next topic, what to do about students who answer incorrectly when it is time to move on, what to do if only a small proportion of students get a question correct, and what to do if students are still confused after the instructor gives his or her best explanation.
* Many instructors use clickers to lead into class-wide discussions, and **leading class-wide discussions can be challenging for instructors used to just lecturing**. See our [Teaching Guide on discussions](https://cft.vanderbilt.edu/teaching-guides/teaching-activities/discussions/) for advice on leading class-wide discussions.

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| “Sometimes students will have questions that as an instructor you might not have thought of. And I use them the next day in class by just bouncing them back to the students. Instead of explaining to them what the answer to the question is, I just pose their question [to the class using a CRS]. I’ve had some students come to me at the end of the lecture saying, ‘Professor Mazur, that question you asked me, that was exactly the question I had.’ And I look at the student and say, ‘That was your question!'”— [Eric Mazur, Professor Physics at Harvard University](https://cft.vanderbilt.edu/docs/highlights-from-a-conversation-with-eric-mazur/) |

**CRS at Vanderbilt**

Top Hat is the first classroom response system to be adopted campus-wide at Vanderbilt. Top Hat will be available to faculty, students, and staff across campus starting July 2017.  Instructors teaching with “clickers” are invited to consider Top Hat for in-class student polling.

Top Hat is a “bring your own device” (BYOD) classroom response system that makes use of students’ personal mobile devices (phones, tablets, laptops) as response devices.  BYOD systems offer a number of logistical and pedagogical advantages over traditional, “clicker”-based systems.

Top Hat was selected by a trans-institutional working group consisting of more than 40 faculty, students, and staff, organized by the Center for Teaching during the 2015-16 academic year.  The group identified a number of useful features of Top Hat in its recommendation:

* Support for both multiple-choice and free-response polling questions, including a number of different question types;
* Compatibility with PowerPoint for integrating polling questions with slides, along with the ability to run questions on top of any presentation software;
* Student response options via mobile devices including Web, text messaging, and a dedicated mobile app;
* Options for sharing polling questions, response distributions, and correct answers with students for review after class; and
* Integration with Vanderbilt single sign-on and Brightspace grade center.

The Center for Teaching serves as the administrative home for Top Hat at Vanderbilt, and will coordinates training and support. You can learn how to sign up for your free account and get started using Top Hat by visiting [vanderbilt.edu/tophat.](http://www.vanderbilt.edu/tophat/)

Questions about the Top Hat adoption?  Contact CFT educational technologist [Rhett McDaniel](https://cft.vanderbilt.edu/about/contact-us/?who=mcdaniel).

**News Articles**

* [With Classroom Response Systems, New Way of Learning Is Only a ‘Click’ Away,](https://news.vanderbilt.edu/archived-news/register/articles/index-id%3D34386.html)*Vanderbilt Register*, April 2007 – featuring Derek Bruff from the Vanderbilt Center for Teaching and Department of Mathematics
* [Learning a Click Away in VUSN Nutrition Class](http://www.mc.vanderbilt.edu/reporter/index.html?ID=4372), *VUMC Reporter*, November 2005 — Featuring Jamie Pope and Bettina Lippert from the Vanderbilt School of Nursing

**CRS at Other Schools**

* [**University of Western Ontario**](http://presswestern.uwo.ca/) The [PressWestern Project](http://presswestern.uwo.ca/) provides support to the University of Western Ontario clicker-using community. The project's [student page](http://presswestern.uwo.ca/students_and_audience/index.html) features short videos explaining how to set up clickers and use them in class. The project's [faculty page](http://presswestern.uwo.ca/instructors_and_presenters/index.html) provides explanation of the technology of clickers and discussing how clickers can be useful in teaching. See also [this video of Tom Haffie](http://www.itrc.uwo.ca/spotlight/mr_tom_haffie.html), coordinator of the PressWestern Project and lecturer in biology, discussing ways and reasons to use clickers.


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