

Teaching with Technology

Volume 2: The Stories Continue

Clickers in a Classroom: Learning Outcomes and Student Reactions

Evan Golub

Background

My department at the University of Maryland offers a technology literacy course for non-majors. This course presented two concerns that motivated me to explore the use of classroom response devices (clickers). First was a desire to improve student performance, specifically regarding retention of certain types of facts. Each year a surprising number of students gave incorrect answers to certain exam questions that had been discussed specifically in class, sometimes in several ways. Previous work (Duncan, 2006) indicated that student attention could be focused on specific material via clickers, which implied that the students would later perform better when tested on this material.

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Clicker-based polling can be used for taking attendance, assessing prior knowledge, administering quizzes, reinforcing key facts, asking general opinion polls, or presenting anonymous opinion polls

The second concern was how to make a large lecture course more interactive and engaging in order to improve the overall course experience and address attendance issues. During previous semesters, when I wanted to bring voices besides my own into a discussion I would pause to ask students to raise their hands to vote on a question, or ask “would anyone like to share a thought on this” at various points. Very few students would raise their hands or offer personal opinions. Additionally, attendance would be fairly high at the start of the term, but I found that later in the semester it would drop noticeably. A small group of students would raise their hands or offer ideas, and that group did not suffer from an attendance drop. This led me to believe that an increased level of overall engagement might encourage better attendance.

Previous work (Cue, 1998; Duncan, 2006; Draper & Brown, 2004) and local discussions indicated that attendance could be improved through daily or near-daily clicker use. In one attempt to use clickers in a course, I simply asked those who already had the devices to voluntarily bring them; this produced less than a 5% response, even though data indicated that approximately one third of our students had them. It was suggested that basing 5% of the semester grade on responding to clicker polls would be significant to students. I also read (Jackson & Trees, 2003) that students who might not have come to class without this requirement could be inattentive or even disruptive in class, so there were some risks associated with this change.

Approach

While there are other ways to have students in a large lecture provide feedback during a class period (a show of hands, pointing to answers with individual laser pointers) the clicker system used here provides a way to collect student answers, display the results, and assign points for participation or correct answers.

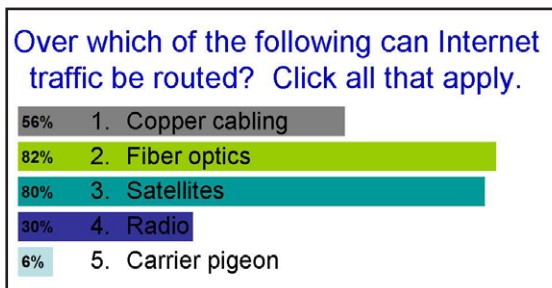


Figure 1: A question that allows multiple responses.

In this exploration I chose Turning Technologies Student Response systems (clickers) for three reasons.

First, its radio frequency (RF) technology scaled well for large classes of 60 to 80 students, as opposed to the competing infrared devices. RF also has a longer range and does not require a direct line of sight. Second, the software provided good functionality. It could display results live in a graphical way through a free PowerPoint plug-in that allowed for easy creation of “poll-able” bullet lists and overlaid results graphs. It also supported saving responses for later use in generating student-by-student reports. The final reason had to do with standardization. The Turning system was selected over others with similar capabilities due to its growing use as part of a campus-wide attempt to standardize classroom response technology. We wanted students to be able to use the devices they were buying more than once, amortizing their purchase over multiple courses. One statistic provided by our information technology (IT) group indicated that almost a third of our undergraduate students had used clickers in at least one class. As part of this initiative, the IT group had also installed the necessary clicker system receiver units in over 100 technology-enabled classrooms.

As indicated, clicker participation was integrated as 5% of the course grade. I also announced in class that the two lowest (or missed) clicker days for each student would be dropped in order to allow for technology glitches. Incorporating the use of clickers was going to require certain alterations in the course, so I took the opportunity to think more generally about how to change the structure of lectures to become more interesting and better convey connections between the class material and societal issues (one of the goals of the course).

Clicker-based polling can be used for taking attendance, assessing prior knowledge, administering quizzes, reinforcing key facts, asking general opinion polls, or presenting anonymous opinion polls. In this course I decided not to use clickers for quizzes, largely because I was not sure the technology was reliable enough. It would be unfortunate if a student’s response to a quiz question did not register, but if the grade were for participation, one missed response out of several polling slides would not cause a problem. I also had concerns about the kind of feedback the device gave; a green light on the clicker indicated simply whether or not a response was received (on newer devices an LCD screen indicates which answer was received). For all these reasons the requirement was participation, not a correct answer.

One strategy for using clicker polling is to use questions to advance through a topic via dialogue instead of pure lecture. Rather than presenting the growth of the World Wide Web on a PowerPoint slide containing factoids, one can present a series of slides

that present information and question students about what happened next. One of my polling slide sequences presented these questions, along with appropriate answer options:

1. Around how many web sites do you think there were in 1995?
2. Around how many web sites do you think there were in 2001?
3. Around how many web pages do you think there were in 2001?
4. Around how many web pages do you think Google currently indexes?

Discussing certain topics openly can be a challenge, especially topics that touch upon controversial, embarrassing, or even illegal activities. Polling can be a useful tool in situations where students may not want to identify themselves with an answer. Clickers allow you to ask students to be honest about these topics without revealing themselves to their peers. The summary data can be used as a discussion point as well as allowing students to consider their reply in the context of the class-wide response. As an example, when discussing copyright, I presented a scenario where a student needs to obtain and read a book during the coming month. Each of the methods in the sequence below was presented on a separate slide and students were asked to indicate whether it was acceptable for someone (not specifically them) to acquire the book in this way:

- Buy the book new.
- Buy the book at a used bookstore.
- Borrow the book from the library.
- Borrow the book from a friend.
- Borrow the book from a stranger who is offering to lend it out on Craigslist.
- Sneak a copy of the book out of a used bookstore and then return it a week later.
- Steal the book from a new bookstore.
- Download a copy of the book off the Internet via a file sharing system.

After polling closed the results were displayed. I followed with questions to the class where the percentages indicated something “interesting” but not too controversial. I was surprised that a very low number of students felt the Craigslist option was acceptable, so I asked students to volunteer why they felt this way. Several quickly raised their hands to share their reasons.

One can also use polling to demonstrate a concept that requires group involvement along with rapid data collection and analysis. After discussing the concept of research and randomness in one class session, I asked students to click a random button number between 1 and 9. The number 7 received

a disproportionately high number of votes and the number 4 not many at all. I commented that when accusations are made about election corruption, officials sometimes study the distribution of the last digit of the tallies in districts. I suggested we try again, hoping to avoid the imbalance of the first poll. In the re-poll, 7 had a disproportionately low number but there were many 4s. I used this as an example of how results can be influenced by subtle changes in wording when choices are presented.

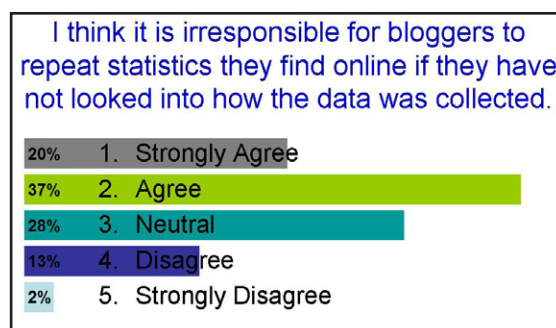


Figure 2: A question that involves a rating scale.

I connected two class topics – Internet journalism and statistics – in a pair of slides with agree/disagree polls on these statements:

- I think journalists should be required to have a background in statistics if they use them in a story they are reporting.
- I think it is irresponsible for bloggers to repeat statistics they find online if they have not looked into how the data was collected.

A discussion ensued among several students – with the context that everyone in the room knew the poll had shown opinions very much split on these issues.

Soon after it was announced that web addresses would be able to contain non-English characters, I presented a slide displaying five web URLs and asked the students to indicate which they felt was a “safe” link. There was no direct lesson in the example, but it served as a way to show how there could be adversarial “cons” created by reasonable and honest decisions made by the organizations in charge of the Internet and to encourage the class to think broadly about the “world” part of the world wide web.

One should have specific goals and an initial plan for how to use response devices across the entire semester, but leave room to be creative and spontaneous in some polling. Your plan should be flexible, with contingencies for technical glitches. A student’s device can break, a classroom receiver can malfunction, or a session of data can be lost. Also remember the cost to your students; we replaced a required book with free online readings in order to reduce the financial impact of purchasing the device.

Polling can be a useful tool in situations where students may not want to identify themselves with an answer

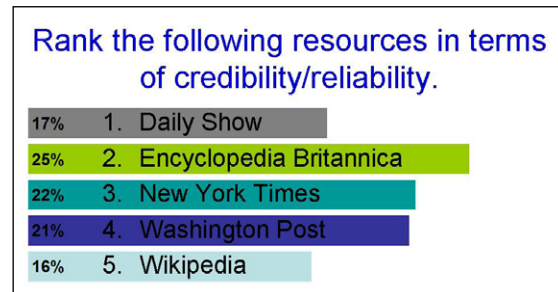


Figure 3: A question that asks for ranking.

Results

After using the clickers for four semesters, I believe that clicker use has been successful at various levels, but not in all of the intended ways. Among the successes, class atmosphere benefited most. For topics that students felt were rather dry, clickers were used to make the class proceed in a more interesting way. During a history lesson, clicker polling was used to advance a time line by asking students in what year they thought a certain technology was created. As mentioned above, when discussing ethical questions, polling was used to walk the class through scenarios. Overall, using graded clicker polling during the semester worked far better than earlier attempts at asking student to vote on things via a show of hands.

Over the course of the semester, when polling was used more students seemed to be actively engaged in the class. This is supported by a poll on the last day of class, where students were presented the statement, "I think that the use of clickers made the class more interesting". 57% of the students responded "Agree" or "Strongly Agree" and 25% either "Disagree" or "Strongly Disagree". This was also reflected in higher attendance overall, which probably helped lead to a perceived reduction in the number of emailed questions regarding project topics explicitly discussed in class.

As the instructor, I enjoyed class more and felt more in touch with the "pulse" of the students as a result of the higher level of interaction created by using clickers. I was able to engage far more stu-

dents than when I simply asked for a show of hands. This inspired me to generate more interesting and thought-provoking polling questions throughout the semester, even after I had moved past the set of polling slides mapped out in advance. Several of the examples mentioned in this essay were the result of such inspiration.

Regarding the score percentage of the final grade, in our first semester of use clicker polling was worth 5% of the course grade and almost every student had a clicker registered. In the second semester it was increased to 7% with no overall differences in the observed outcomes.

While attendance did stay higher throughout the semester (70 - 90%) there was not a strong correlation between participation in polling and performance on the corresponding exam questions on that material. There was an exam question about secure clients and servers that I would ask each semester and many students answered incorrectly. When I began using clickers, I presented a total of four polling slides that asked about this topic in different ways. As expected, many students gave incorrect answers during polling and I revisited the topic to review and expand upon the correct answer. Nevertheless, large number of students still gave incorrect answers to exam questions that topic.

At the time of the first exam students had seen perhaps a dozen multiple-choice questions with "right answers" on polling slides and a half-dozen opinion-based questions. The objective items became an interesting (if potentially skewed) initial "test" of the clickers themselves, as I simply incorporated those questions onto the exam verbatim to see how students responded. The class average on those questions ended up being lower (63.24%) than the average on the rest of the exam questions (70.63%). In fairness, many of the questions were chosen for polling because they represented difficult concepts. It was also possible that the average was brought down by students who did not attend to participate in the polls.

For the 69 students who took the final exam in Fall 2008, I ran Pearson correlation tests between individual clicker participation points and clicker exam question scores. Correlations and scattergrams of student data did not show a significant relationship. The Pearson correlation was only 0.51. I used the same question-writing approach on the second exam with a similar number of items. The class average on those questions ended up being slightly higher (71.20%) than the average on the rest of the questions (68.14%). However, analysis again showed no significant correlation between grades on clicker

One should have specific goals and an initial plan for how to use response devices across the entire semester, but leave room to be creative and spontaneous in some polling

Turning Graded Participant Results						
Session Name: ExampleQuizAnswers Created: 9/13/2010 10:58 AM						
Device ID	LDAP	First Name	Last Name	1) In what year was the computer mouse invented?	2) Which of the following are even numbers? Click all that apply.	Total Points
301B8A	jd223	Doe	John	4 i	3 c	25
301BAE	js925	Smith	John	3 c	5 i, 3 c	65
30183B	jd035	Doe	Jane	3 c	3 c, 2 i	65
301845	js927	Smith	Jane	3 c	3 c, 1 c	100
30193F	pd564	Doe	Pat	1 i	4 i, 1 c	15

questions and their participation in polling. The Pearson correlation was 0.43 in this case.

For the final exam I used the same approach to generate new questions, and all previous clicker-based questions were asked once more. The class average on those questions ended up being much higher (78.54%) than the average on the rest of the questions (63.06%). However, once again analysis showed no significant correlation. The Pearson correlation was only 0.40. For Spring 2009, the first exam was designed in the same manner as Fall 2008, and once again no strong Pearson correlation was seen. No further correlation tests were conducted.

An interesting pattern related to clicker participation re-affirms the adage that “showing up is half the battle”. Students with high course grades had high rates of clicker participation. This is not a measure of the effectiveness of clickers, but it is an interesting data point in terms of class attendance and overall performance.

Semester Grade	Average Clicker Participation Grade
A	88.6%
B	84.3%
C	76.2%
D - F	59.1%

Students were asked about their attitudes towards clickers at the beginning and end of the term. At the beginning, after three practice days of clicker use they were asked to provide Likert-style answers (Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree) to statements such as “I think the use of clickers will lead me to come to class more often.” At the end of the semester reworded statements were presented, such as “I think the use of clickers lead me to come to class more often.”

When asked whether clicker use would/did lead them to come to class more often or make class more interactive, they generally agreed that it would, although some shifted to neutral on these statements at the end of the semester. The last polling slide asked whether they thought clicker use would make the class more interesting. Feelings varied on this initially, but moved towards mostly agreeing by the end of the semester. Detailed results of this polling can be found at <http://www.cs.umd.edu/~egolub/ClickerResearch/ClickerPerceptions.shtml>

Recommendations

I decided to continue using clickers with this course because of their positive classroom benefits and the fact that they appeared lead to an increase in attendance. An increase in class participation as well as the potential to rejuvenate my view of a course significantly influenced that decision. Being aware of the strengths and potential weaknesses in advance should temper expectations and shape the use of polling.

The potentially disruptive students that Jackson and Trees mentioned did not show themselves. Whenever I did polling at the start of class I did not poll at the end. After students learned this, there would typically be a small number who would get up and leave after I ended the polling session and closed the slides. They generally sat in the back of the room and were able to leave without disrupting the class as a whole.

Future plans include exploring whether it is possible to take advantage of the positive observations via occasional use in other courses, without having any portion of the class grade assigned to participation. A more controlled study might be designed in which two sections of the course taught by the same person would differ only in whether they used clickers during class. The facts from the clicker questions would be presented in both classes, but polling would only be done before revealing the facts in one class. Additionally, some facts would be presented but not polled on in both classes. Student performance on the exam questions would be recorded item by item for comparison.

Turning Statistics Report						
Session Name: ExampleData						
Created: 8/19/2010 2:43 PM						
Mean Correct %: 60%						
Median Correct %: 50%						
Mode Correct %: 50, 100%						
Device ID	User ID	Last Name	First Name	Total % Correct	vs Mean	vs Median
301B8A	jd223	Doe	John	100%	+40%	+50%
301BAE	js925	Smith	John	50%	-10%	0%
30183B	jd035	Doe	Jane	0%	-60%	-50%
301845	js927	Smith	Jane	50%	-10%	0%
30193F	pd564	Doe	Pat	100%	+40%	+50%

References and Resources

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Web Resources

- 7 Things You Should Know About Clickers (Educause, 2005). <http://net.educause.edu/ir/library/pdf/ELI7002.pdf>
- A TurningPoint Guidebook for Educators” (Evan Golub, 2010). <http://www.cs.umd.edu/~egolub/TurningPointGuidebook/>
- Turning Technologies Student Response systems (Clickers). <http://www.turningtechnologies.com/studentresponsesystems/studentclickers/>

The Learning Technology Consortium

The LTC began in 1998 as a partnership of institutions with similar instructional goals, strong technology and faculty support programs, and an interest in collaboration around teaching and learning with technology. The members are:

- University of Delaware
- University of Florida
- University of Georgia
- University of Maryland
- University of North Carolina at Chapel Hill
- University of Notre Dame
- University of Pittsburgh
- Virginia Tech
- Wake Forest University

Representatives meet semiannually at one of the institutions, where members tour specialized facilities and discuss the selection and use of learning technologies, benchmarking, and collaboration.

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