

Quit Surfing and Start “Clicking”: One Professor’s Effort to Combat the Problems of Teaching the U.S. Survey in a Large Lecture Hall

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TEACHING AN INTRODUCTORY SURVEY COURSE in a typical lecture hall presents a series of related obstacles. The large number of students, the size of the room, and the fixed nature of the seating tend to maximize the distance between instructor and students. That distance then grants enrolled (usually first- or second-year) students enough anonymity to skip class too frequently and offer only limited attention when there. The advent of wireless Internet service has compounded the problem by bringing lecturers into competition with Facebook and other Web sites that have a high potential to absorb student-viewers, and thus seem to offer more significant distraction than texting, or its predecessor, note-passing. Seating charts, mandatory attendance policies, banning laptops, even roving teaching assistants can force order and mannerly classroom behavior, but usually at the cost of a collegial atmosphere, and without ensuring that those with nothing left to do but pay attention will do so, let alone engage in the material. Long before the term “active learning” gained caché, I developed a teaching style that relied on discussion and occasional in-class exercises, as did many of my colleagues. For those of us who depend upon class participation, this lack of engagement lies at the center of our dissatisfaction with how the survey class is taught at most large public universities. Discussions and questions posed mid-lecture invariably engage only a handful of “smart” and/or confident students

who do not mind speaking in front of a hundred (or more) strangers. The majority of students who do not fall into these categories often see this element of a lecture as something that does not concern them, or worse, a waste of time, and wait passively until the “real” material (i.e., that which will appear on the test) starts up again.

In the spring of 2004, a publishing representative introduced me to classroom response systems (CRS), alternately referred to as audience response systems, personal response systems, classroom response technology, electronic voting machines, “clickers,” and a host of similar names. This wireless classroom technology allows every student to respond with handheld devices to multiple choice questions posed by the instructor, most commonly via PowerPoint and a projector, though some programs pose the questions in other formats. All transmitted answers are picked up by a receiver connected to the instructor’s computer, whose software then allows two things to happen. First, the instructor can immediately display a histogram that represents the aggregate responses to the question, and later, s/he can discern how (or whether) individual students answered. Thus clickers both allow instructors to engage the entire class in participation, and provide records of who is attending class and more or less paying attention. The most typical use is to intersperse a number of questions (usually between four and six) throughout a lecture, though other uses include reading quizzes, tests, and games. Despite the fact that I am not generally inclined to embrace new technologies (at the time, I still used an outline on an overhead projector rather than PowerPoint presentations, and I have not yet developed a Web site or employed a Web-based class management system), my frustrations with large survey classes made this innovation appealing, so I adopted it for two sections of “U.S. History to 1865” in the fall of 2004.

Since then, my encounters with CRS have left me with a good deal of knowledge, mostly positive, about the systems and their use in large enrollment courses. Between 2004 and 2008, I have: a) used three different classroom response systems over the course of six semesters (Interwrite PRS, Turning Point, and eInstruction); b) participated in a task force that evaluated all such systems then on the market and ultimately recommended one (eInstruction) that my university standardized on, and; c) completed two years of a three-year pilot project designed to test the efficacy of clickers in large classrooms, sponsored by my university’s Quality Enhancement Plan (QEP). My own classroom experiences, as well as a growing body of evidence from non-history users of this technology, points to several advantages.¹ Implementing a CRS component in a large lecture course improves attendance, increases class participation, and generally makes lectures more enjoyable for students, by their own report. But to my mind,

the most important effect is on the teacher. The process of crafting the best questions before class and determining how to respond to the variation in student answers during class makes it more likely that I will recognize and address gaps in students' comprehension and reasoning well before the test. Because they fit with my teaching style and goals, clickers promote my ability to help a broader range of students think like historians, and with better success than I encountered with lecturing, limited class discussions, and essay tests alone.

The following overview of my experience with clickers in a U.S. history survey course points out potential pitfalls and highlights what has been helpful in the larger audience response system literature. This literature is at somewhat of a remove for historians because the vast majority of CRS adopters (and thus most published studies) have been in the hard sciences, especially physics, engineering, and medical education, where different teaching methods, chiefly application and problem solving, dominate.² Nevertheless, as will be clear below, some of their insights about the best sort of questions to ask and how to ask them have come to influence my own approach. My relative success in using clickers to teach critical thinking skills occupies the second part of the essay, including a brief case study of my strategy in teaching slavery at the survey level.

Early reports about—and my own experience with—CRS were mixed. Like most adopters, I found that students enjoyed “clicking” both for its novelty and because they liked participating and getting credit for it, though they resented the cost and interruptions brought by technical difficulties. From my end, I shared typical instructors' rewards of improved attendance (with “clicker classes” having as much as six percent higher attendance rates) and a more engaged classroom.³ But unlike physics or statistics professors who could use the system to see if a majority of students could solve a problem based on a recently explained formula or concept, and then make a decision to move forward or not, I did not immediately see a corollary within the history lecture. In other words, it was not clear that the benefits outweighed the downsides of technical difficulties, cost, and what initially seemed to me a somewhat circumscribed number of uses in a typical history classroom. For the most part, I can now report improvement in all of these areas.

Not surprisingly, dramatic technical innovation offers the clearest example of improvement. Whereas the first classroom networking systems had to be hard-wired and installed by educational institutions themselves—making them expensive and uncommon—by 2004, when I began, wireless technology permitted individual instructors to adopt the system without any cost to (or approval by) the college or university.⁴ CRS suppliers usually provide receivers free to instructors of large classes,

knowing that enrolled students are then required to purchase the clickers (alternately referred to as response pads, transmitters, keypads, handheld devices, or remotes). In my first semester with CRS, the transmitters sent infrared (IR) signals, which had to be picked up by receivers permanently mounted on the walls at the front of the classroom. Too many responses sent at the same time jammed the system, and fluorescent lighting occasionally caused interference (begging the question of whether there existed a university classroom without fluorescent lighting), all of which resulted in slow assembling of student responses, with each question often taking several minutes of class time. Though acquiring and learning the basics of the software presented few problems, some tasks proved frustrating. In particular, for the first two systems I used, the procedure by which the instructor linked the identifying number for each student's clicker to the class roll was not intuitive; my mistakes meant that I spent a good deal of time collecting information about attendance and participation by hand when it should have been easily tallied by the program. Software improvements have resolved most (but not all) problems concerning roster creation, and in any event, I have found technical support for higher education users to be helpful and (usually) quick. Most importantly, radio frequency (RF) technology has replaced the problematic IR devices in large classrooms. RF clickers have indicators that inform students whether their answers have been received, do not require the installation of bulky receivers, and never jam. Setup time is minimal (less than five minutes before class) and even very large classes can see histograms of aggregate responses almost instantly upon the end of polling.⁵

The improvement in transmitter technology mirrors the rapid change in CRS technology overall, and for the marginal technophobes among us, this has a troublesome as well as benign side. Instructors can count on new iterations of software regularly, as well as redesigned hardware. One system (Interwrite PRS, recently merged with eInstruction) offers a robust clicker that allows a variety of question formats, including short answer, as well as a homework mode. This company has also recently introduced the use of laptops or PDAs as "virtual clickers" which can be used in classrooms with RF clickers. Appreciable differences between competing systems exist as a result, and prospective adopters of a CRS system are advised to spend a bit of time getting informed, rather than just accepting the report of a publishing or CRS representative. Once users have adopted a particular system, they may find keeping abreast of technical advances takes time, but can improve the classroom experience. Users are not obligated to adapt to each new innovation, however, as all the companies I have dealt with have continued to support older models of hardware and previous iterations of software.

A problem related to technological innovation—students' complaints about cost—has not been as easily resolved, but a number of issues have mitigated their expenses. The retail price of clickers depends on the system, as some companies charge more upfront for the transmitter, while others add a per-semester registration fee to a lower-priced response pad. On average, the cost to students ranges from \$35 to \$50 a semester, though occasionally, publishers offer rebates to those who purchase new texts.⁶ While costs have risen slightly, more widespread use means a decrease in the cost-per-course, as long as all the courses are using the same system—if not, students find themselves purchasing and carrying multiple brands of clickers. To avoid this expensive proposition, and to make a campus-based support system feasible, many universities, including my own, have chosen to standardize, and then pressed faculty to adopt only that system. At this time, my participation in my university's QEP project has solved the cost problem altogether; an institutional grant supplied my department with 150 clickers which I distribute and collect at the beginning and end of each class. Though I was initially concerned that this process would be confusing and time-consuming, that has not proven to be the case. Distribution and collection takes a few minutes, and it solves the problem of students' forgetting or losing clickers, or refusing to buy them altogether. Before we supplied clickers, the average number of lost, forgotten, broken, or never-purchased clickers ran about five to ten percent each class.⁷

Although insights I can offer about overcoming technical and financial obstacles are helpful, they are less important than what I have learned about how best to use CRS to improve survey-level teaching. Given that the “problem solving” application commonly discussed in the math and science CRS literature did not at first translate for me, I initially embarked on a less ambitious approach. Oftentimes, I asked “icebreakers” to get students involved and/or interested at the beginning of class, and then stopped intermittently throughout the lecture—often after discussing a difficult concept or showing a film clip, but sometimes after ten minutes of straight lecture—to test their understanding and/or attentiveness.⁸ These questions are embedded within my PowerPoint slides, so the process of displaying the question, allowing the students about thirty seconds to transmit their answers, finding out through the resulting histogram the percentage of right and wrong responses, and briefly explaining the correct answer to those who had missed it initially occupied only two or three minutes of lecture time.

A few examples should suffice. The opening/icebreaker question for my lecture on the Puritans asks students to identify which statement accurately reflected Puritan life, with the five multiple-choice possibilities referencing Puritans' 1) condemnation of alcohol, 2) preference for all-black clothing,

or 3) disapproval of sex in general, or reading 4) “all of the above” or 5) “none of the above.” Reflecting popular misconceptions, most chose “all of the above,” despite, of course, that Puritans drank, wore bright colors, and permitted “bundling.” When the histogram appearing on the screen inevitably loads toward incorrect answers, I point out that that the vast majority of the students surely need the day’s lecture because they have much to learn about Puritan life, a suggestion that is usually met with a bit of good-humored agreement.

On a slightly different tack, I sometimes seek the opinions of my students on philosophical or political issues related to the lecture material. These questions do not have a right or wrong answer, of course, but can illustrate the continued relevancy of a historical disagreement, help to explain how context shapes individual responses, or indicate the varied points-of-view within a classroom. Prior to my discussion of Alexander Hamilton and Thomas Jefferson, for example, I offer two different characterizations of the nature of humanity and thus the best role for government, based on the ideas of each man, keeping the philosophers unidentified. After students have voted on which one seems more accurate, I reveal that those who chose option one will likely find their political philosophy origins in Hamilton, and those who chose option two will perhaps identify more with Jefferson. Though on this occasion, the opening question is directly related to one of the lecture’s major conceptual points on the relationship of contrasting philosophical outlooks to the political development of the new nation, I do not make such a connection a priority. Rather, I tend to use the first question to hook interest with “fun facts” or contemporary associations.

The questions I pose at intervals throughout the lecture require analytical thinking a bit closer to “comprehension” and “application” rather than “recall” (to use Bloom’s taxonomy). Recall questions can tell me who is paying attention or is keeping up with reading assignments, as well as remind students that I will now have a record of their lapses. But more challenging questions that ask students to apply information in a new context are more engaging and instructive. After explaining the concept of Southern honor, including the role of dueling among social equals as a means of maintaining one’s reputation, I ask them to imagine themselves as a planter who must decide how to respond when hearing that his overseer had insulted the virtue of the elite man’s wife or daughters. If their first impulse is to pick the “challenge him to a duel” option over “thrash him with a cane,” I know I need to spend a bit more time emphasizing the importance of social status in the Old South. In a similar vein, an exercise in which I masquerade as a law school professor requires me to explain Chief Justice John Marshall and his Federalist principles and priorities,

give the facts of a series of important cases, and then use clicker questions to challenge students to ascertain Marshall's decision in each one. Those who have committed to an answer and discovered it incorrect are generally more engaged in hearing an explanation of why, allowing me to explain more carefully the Federalist world view.

As I considered how to broaden this dynamic with my lecture—and, not coincidentally, simultaneously attended a series of teaching workshops on active learning as part of my obligation to the university's QEP—I discovered that immediately disclosing the correct answer missed an opportunity. The software can lead an instructor in this direction, and in fact, one program I used was not even equipped to give credit for right or wrong answers unless the correct answer was marked at the time the question was written, that is, before class. But as I learned more about the principles of active learning and peer instruction (and how best to use new CRS software), I recognized that delaying my intervention brought significant benefits.⁹ Now when a histogram indicates that a majority (or even large minority) of students answered incorrectly, I stop lecture for three or four minutes, and ask the students to consult with their notes and one another, and then repoll. At this point, I may ask groups who voted a particular way (for the correct answer or not, depending on what I think will be more helpful) to explain their answers, or I may try to get such explanations from those who have changed their votes from the first poll to the second. Eventually, assuming there is a right answer (more on that below), I will clarify that for the class, often employing in part the words supplied by a classmate.¹⁰

Allowing the class to discuss questions takes more time, and means that I have to omit some content, but my experience and the scholarly literature tells me it is worth it. The short discussion periods offer students an opportunity to instruct one another, and to start working with the material while still in class. Educational theorists going back to Dewey have recognized the importance of responding to learners' needs but, more directly, several studies of the efficacy of clickers have found that students are more likely to work out a problem if first asked to do so in class. When they do not understand a new concept, they may be able to learn it more easily from a peer who has just figured out for him/herself and may use a more familiar vocabulary. Moreover, they become more comfortable with expressing their own problems with a concept, in part because they can see others are in the same predicament, and in part because there is so much classroom chatter (at that point) anyway. Students ask more questions, and better questions, and the quality of discussion improves as a result.¹¹

Emboldened by the possibilities of such discussions, I began to include more questions that depended on historical interpretation, and so did not

have an indisputably correct answer.¹² The fact that history relies on skilled interpretation of imperfect evidence is a major theme in my course, and for several years, I have pressed this point in a somewhat infamous lecture on Bacon's Rebellion, where I refuse to clarify what caused it, and what (if anything) made it important. Along with confronting the conflicting answers to those questions on Web sites, in textbooks, and by listening to my synopsis of several different historians, students observe contradictions in assigned primary sources from Nathaniel Bacon, Governor William Berkeley, Robert Byrd, and others. During class, I pose a series of clicker questions that ask students to discern the "right" meaning of a few of these sources, and to decide what is the most accurate explanation for a key issue, such as why so many frontier residents joined Bacon's army. Because in this instance they must eventually write a short essay adequately supporting one of the several theories I have presented with the primary source evidence at their disposal, I offer little resolution after these debates (with the promise that I will not leave so much up in the air in any future lecture, as long as they remember that every lecture could conceivably be as open-ended as the one on the 1676 conflict in Virginia). More often, however, I offer a clearer explanation of what causes historical interpretations to differ, and why I find one option more convincing. After a presentation on the Whiskey Rebellion, for example, I may ask them to assess whether the event represented a victory of the Federalists or continued liberalism in American political views. Here the answer is both, depending on how one weighs various aspects of the Whiskey Rebellion and its aftermath, a point many arrive at once they begin to try to persuade their discussion partners of one answer over another.

Beyond the satisfaction that comes from witnessing introductory students debate such matters, this process often highlights my students' need for assistance in developing their critical thinking skills. When they stumble over an issue such as the relative conservatism or liberalism of an event like the Whiskey Rebellion, I step back, and model how I would approach such a question—settling on a definition, creating categories, and systematically going through the evidence.¹³ Again, this takes more time away from content lecture, but I believe it has improved the quality of essays I have received and has the potential to endow some students with skills they desperately need.

While most instructors who use CRS believe it helps students understand complicated material better, hard evidence that clickers promote the development of such skills or other student learning outcomes is difficult to come by. To date, few have even attempted to implement appropriately rigorous research designs, and those that *have* recognize the implicit difficulties in attributing any gains to one source (the use of clickers) over

other possible explanations.¹⁴ In response to continuing questions about the benefits of active learning strategies (and to satisfy the Southern Association of Colleges and Schools reaffirmation process), my university embarked in 2007 on an ambitious, three-year project to discern which active learning strategies work best, and in what sort of environment (from large lecture halls to small seminars), and with what sort of students.¹⁵ My part in this project is to teach two sections of the same introductory history course, using clickers in one (the experimental section), but not the other (the control). The research committee has devised a series of tests and surveys to track students' progress, attitudes, and effort, compiling reams of data in the attempt to distinguish which achievements come from the different teaching strategy, and which are explained by differences in differences in SAT scores, age, commitment and interest in the course, etc. Unfortunately, this commendable if exhausting thoroughness has not yet overcome all the barriers to assessing the added value of clickers, and may not ever do so. After completing the second year of the study, we could confirm that attendance is better with clickers than without, even when attendance is taken in both classes. Further claims about the effect of clickers on critical thinking skills are provisional at best.¹⁶

All the same, the last year of research on teaching has left me with a good deal of anecdotal evidence and suggestive data. A case study on the impact of clickers on my presentation of the history of slavery offers a brief illustration. Because the topic of slavery comes relatively late in the semester, I insist that students be prepared to develop independently a position on a (somewhat simplified version of a real) scholarly debate about antebellum slavery. Over the course of two lectures and a class-wide discussion of Frederick Douglass's *Narrative*, I set forth two competing explanations for how slaveowners maintained control—through the mutual development of a paternalistic relationship with their slaves or by commanding brute force over them. I note that over the years, historians have legitimately differed on the relative importance of these internal and external factors in maintaining slaves as a profitable labor force. For one of their final exam questions, I expect students to be able to provide competent support for one position or the other, or to explain how shifting contexts made one more common than the other. Clicker questions and small and large group discussions in which students try to convince one another of the meaning of some of Douglass's stories help students figure out how to organize and interpret their data.

My research associate, Gregory Kosc, compiled student responses to a set of questions we asked in the fall of 2007, looking for evidence on the effect of clicker questions and discussions on student views over the course of a class period. Did students answer the same question (about

the influence of paternalism) at end of the second lecture differently from when they had at an earlier instance? He then compared those responses to their exam performance, to ascertain whether, or how well, a perspective gained over the course of a clicker-based discussion session shaped their final analysis. Though the size of the pool was small (twenty-three) due to our requirement that all students had the same grader (me) and wrote on the same topic, the correlations were significant. Of the twenty students who attended both lectures, one-quarter (five students) did not reflect any alteration in outlook, but three-quarters (fifteen) did. Of the fifteen students who at some point changed their minds during the discussion or before the final, eleven showed such a development while in class, apparently in response to clicker questions and post-question discussions; four did so between the lecture and taking the exam, perhaps reflecting on a remembered exchange, though it is equally likely the change was the result of some other instruction or influence. Of the eleven who gained a new understanding during class, only one still went on to write a mediocre final essay that lacked a clear conceptual handle on the issue, suggesting that the discussions helped students understand the dimensions of the debate and how to marshal the appropriate evidentiary support for one view over the other. Determining the impact of the clicker method on the five students whose exams and clicker responses were always the same is more difficult. The absence of movement may have emerged from a solid confidence in their own understanding of the concept and evidence from the beginning, or it may have been the result of their decision to push a button without thinking, and refusing to engage in the thinking I was asking them to do. My suspicion is the latter, as only two of the “non-changers” wrote capable essays with appropriate levels of evidence, argument, organization, and conceptual understanding on display. Though the other three were in class and responding to questions, apparently nothing I did helped them to understand what was expected of them, or otherwise motivated them to figure it out before the final. Such students suggest the limits of clickers to intervene in student learning. On a more positive note, four of the five best-written essays came from the group who were present and (apparently) engaged; of the three students who missed a lecture and their fellow students’ discussions, two wrote dreadful essays.

Even if I had much stronger evidence for the efficacy of clickers in improving student achievement in the survey class, I would not suggest that every instructor rush to adopt them. Whether or not this pedagogical strategy is worth implementing depends on a number of factors. The first involves the nature of your institution’s students. One study aimed at assessing the appeal of CRS for students who typically refrain from participating (represented heavily by foreign and female students) found

that most non-participants report a positive experience. The one group in the study who did not like clickers, however, were those who believed that all instruction needed to come from teacher/experts and who resented being required to attend class when such was not the case.¹⁷ Schools characterized by a high proportion of such traditional learners may find clickers a difficult sell, while those with large numbers of students who are uncomfortable participating may find a transition to them easy. In my own experience, those who were most strident in their expression of dissatisfaction with the system (apart from issues of cost or technical difficulty) were those who liked talking in class and were often good at it. They both missed having the same opportunities and resented the fact that typical non-participants got credit for participation. (As one evaluator who “hated” clickers explained, “I don’t need participation help, and my test scores speak for themselves.”¹⁸) In a similar vein, like any instructional reform intending to reach a broader cross-section of students, especially those who lack sufficient preparation for the critical thinking expected in college, the risk of losing the interest of the best student increases. I have not had significant complaints on this score yet, in part because my analytical approach is novel to most students, but I remain wary of oversimplifying course content. Those with well-prepared students may find this potential trade-off too costly.

A second major element of deciding on whether to try clickers depends on one’s strengths as an instructor. The classroom is intermittently chaotic, and instructors have to have the force of personality or discipline to keep a rein on that chaos. Moreover, they need to be ready to respond when students’ discussions occasionally spark a new direction. Those new to the classroom in particular may be less welcoming of the opportunity to address what their students want to know, as opposed to what they are prepared to tell them. On the other end of the spectrum, those seasoned instructors who regularly keep students transfixed with their superior lecturing capabilities would probably find dealing with these issues counterproductive, unless they are looking for new challenges or are concerned about particular lapses in student achievement.

For my part, I have found that clickers have suited my strengths as well as my teaching goals. I cannot state categorically that my students are smarter or even happier since I have introduced this technology, but I do think I am a better survey-level teacher. Certainly, student performance on tests had long demonstrated their gaps in knowledge and organizational and analytical skills, gaps I would try to fill after the fact, before the next test or with the next batch of students. Now, I can intervene before lame essays disappoint us both, and have the pleasure of beating out MySpace for my students’ attention in the process.

Notes

1. One compilation of the early literature on implementation of classroom response technology notes that of twenty-six studies, most report “greater student engagement (16 studies), increased student understanding of complex subject matter (11), increased student interest and enjoyment (7), heightened discussion and interaction (6), increased student awareness of individual levels of comprehension (5), and increased teacher insight into student difficulties (4).” See Jeremy Roschelle, William R. Penuel, and Louis Abrahamson, “The Networked Classroom,” *Educational Leadership* 61, no. 5 (February 2004): 52. For a more in-depth literature review, see Carmen Hedwig Fies, “Classroom Response Systems: What Do They Add to an Active Learning Environment?” (Ph.D. diss., University of Texas, 2005), 10-44. More recently, all of the authors collected in David A. Banks, ed., *Audience Response Systems in Higher Education: Applications and Cases* (Hershey, PA and London, U.K.: Information Science Publishing, 2006) testify to increased student attendance and participation and the impact of CRS on the instructor’s inclination and ability to intervene in critical thinking skills.

2. A review of the specializations of the authors in Banks, ed., *Audience Response Systems in Higher Education*, and a compilation completed by Charles R. Graham et al., “Empowering or Compelling Reluctant Participators Using Audience Response Systems,” *Active Learning in Higher Education* 8, no. 3 (November 2007): 236, indicate that the most common fields are physics, computer science, education, engineering, physical science, psychology, and accounting. I have found two case studies by political scientists [Danny Damron and Jonathan Mott, “Creating an Interactive Classroom: Enhancing Student Engagement and Learning in Political Science Courses,” *Journal of Political Science Education* 1, no. 3 (2005): 367-383 and Robert Webking and Felix Valenzuela, “Using Audience Response Systems to Develop Critical Thinking Skills,” in *Audience Response Systems in Higher Education: Applications and Cases*, ed. David A. Banks (Hershey, PA and London, U.K.: Information Science Publishing, 2006)], and one in philosophy [S. A. J. Stuart, M. I. Brown, and S. W. Draper, “Using an Electronic Voting System in Logic Lectures: One Practitioner’s Application,” *Journal of Computer Assisted Learning* 20, no. 2 (April 2004): 95-102], but none in history.

3. In the fall of 2007, I taught two sections of the U.S. survey, each with approximately 120 students. One section used clickers and one did not. The clicker class had a statistically significant six percent increase in attendance. Attendance was taken in both classes, and participation required in both; the clicker class had 83.4 percent attendance over the course of the semester and the non-clicker class had 76.8. In the fall of 2008, the same protocol was observed. Disparities in attendance rates were not statistically different in this year, but the patterns of attendance still demonstrated the ability of clickers to keep students coming to class. Chronic absenteeism (more than 30 percent absences) was very rare in the clicker class, but there were three times as many cases in the control/non-clicker class. Anonymous end-of-term evaluations regularly included comments about how clickers “kept us paying attention,” “made things interesting,” and were “cool.” In each class where students purchased clickers, about three to six percent protested the “ridiculous” cost or otherwise noted that the cost outweighed the benefit. Course evaluations from 2004 to 2008 are in possession of the author.

4. For an overview of the evolution of this technology since the 1970s, see Ray A. Burnstein and Leon M. Lederman, “The Use and Evolution of an Audience Response System,” in *Audience Response Systems in Higher Education: Applications and Cases*, ed. David A. Banks (Hershey, PA and London, U.K.: Information Science Publishing, 2006).

5. eInstruction claims up to 1,000 responses can be calculated instantaneously (“Classroom Performance System, Radio Frequency,” <<http://www.einstruction.com/Products/CPSRF/index.cfm>>), while Interwrite PRS claims their technology permits up to 2,000 responses (“Interwrite PRS” <<http://www.einstruction.com/products/assessment/prs/>>).

6. Though payment structures differ, two models suggest the typical approach: eInstruction pads cost about \$22, with a per-semester use fee of about \$13 for the first three semesters of use (and thereafter registration is free); Interwrite PRS pads cost approximately \$55, but do not require registration or user fees at any time.

7. Quintin Cutts, “Practical Lessons from Four Years of Using an ARS in Every Lecture of a Large Class,” in *Audience Response Systems in Higher Education: Applications and Cases*, ed. David A. Banks (Hershey, PA and London, U.K.: Information Science Publishing, 2006), 75-76 shares my assessment of the advantages of school-purchased CRS kits rather than individual student-purchased clickers. These kits work in at least two different ways: In one type, instructors create a roster with each student assigned a specific numbered clicker which s/he picks up from the kit before each class; in another type, students may use any clicker in the kit, but must enter their own identifying number before starting class. While the benefits of not relying on students to purchase clickers are significant, it bears mentioning that such a purchase represents a substantial investment (approximately \$5,300 to \$8,000 per 150 students).

8. Eugene Judson and Daiyo Sawada, “Audience Response Systems: Inspid Contrivances of Inspiring Tools?” in *Audience Response Systems in Higher Education: Applications and Cases*, ed. David A. Banks (Hershey, PA and London, U.K.: Information Science Publishing, 2006), 30 note that “lecture pacing” is a typical first method of using classroom response technology.

9. The best source here is Eric Mazur, *Peer Instruction: A Users Manual* (Upper Saddle River, NJ: Prentice Hall, 1996). An interesting assessment and review of the educational benefits of active learning methodologies highlighting CRS specifically can be found in William R. Penuel, Louis Abrahamson, and Jeremy Roschelle, “Theorizing the Transformed Classroom: Sociocultural Interpretation of the Effects of Audience Response Systems in Higher Education,” in *Audience Response Systems in Higher Education: Applications and Cases*, ed. David A. Banks (Hershey, PA and London, U.K.: Information Science Publishing, 2006), 188-201.

10. Scholarship on peer instruction divides on the best procedure. Mazur advocates getting students to make an individual commitment before breaking down into pairs or groups to discuss the problem. R. J. Dufresne et al., “Classtalk: A Classroom Communication System for Active Learning,” *Journal of Computing in Higher Education* 7, no. 2 (March 1996): 3-47 maintains that discussion with the whole class and then small groups should proceed polling. Engineering instructors who tested the benefits of both procedures leaned toward the former, but suggested that the best process depends on the complexity of the problem, with the most complex issues requiring “class-wide talk” prior to polling. [See D. J. Nicol and J. T. Boyle, “Peer Instruction versus Class-wide Discussion in Large Classes: A Comparison of Two Interaction Methods in the Wired Classroom,” *Studies in Higher Education* 28, no. 4 (October 2003): 457-473.] Perhaps because of the size of my classes and the nature of my questions, I prefer Mazur’s individual response—then small-group discussion of responses—then repolled question method.

11. See S. W. Draper and M. I. Brown, “Increasing Interactivity in Lectures Using an Electronic Voting System,” *Journal of Computer Assisted Learning* 20, no. 2 (April 2004): 81-94; Louis Abrahamson, “A Brief History of Networked Classrooms: Effects, Cases, Pedagogy, and Implications,” in *Audience Response Systems in Higher Education: Applications and Cases*, ed. David A. Banks (Hershey, PA and London, U.K.: Information

Science Publishing, 2006); Judson and Daiyo; Webking and Valenzuela; as well as Nicol and Boyle for further discussion of the appropriate educational theory and studies linking CRS to critical thinking achievement.

12. Charles Anderson and Kate Day, "Purposeful Environments: Engaging Students in the Values and Practices of History," *Higher Education* 49, no. 3 (April 2005): 319-343 contends that instructing students about the practice of history and especially historians' imperative to weigh evidence are central concerns pressing for the creation of interactive lecture halls.

13. For the most part, my strategies for modeling historians' critical thinking skills are of my own devising, but I have gained valuable advice and suggestions from Charles Bonwell and James A. Eison, *Active Learning: Creating Excitement in the Classroom* (Washington, D.C.: School of Education and Human Development, George Washington University, 1991) and Thomas A. Angelo and K. Patricia Cross, *Classroom Assessment Techniques: A Handbook for College Teachers*, second ed. (San Francisco, CA: Jossey-Bass, 1993).

14. The most common findings of studies about the benefits of CRS are listed in note 1 above. One of the few studies to make a serious claim for the ability of classroom response technology to improve learning outcomes using a rigorous research design is Neville W. Reay, Pengfei Li, and Lei Bao, "Testing a New Voting Machine Question Methodology," *American Journal of Physics* 76, no. 2 (2008): 171-178. Another study by Reay et al., used a control and experimental model to prove that students, especially female students, in the experimental classroom with clickers performed better on conceptual questions on tests—see Neville W. Reay et al., "Toward the Effective Use of Voting Machines in Physics Lectures," *American Journal of Physics* 73, no. 6 (June 2005): 554-559.

15. For information on UTA's QEP program, "Active Learning: Pathways to Higher Order Thinking," see <<http://activelearning.uta.edu/qep/qep.htm>>.

16. Personal communication with Vice Provost David Silva, University of Texas at Arlington, August 15, 2008 and February 26, 2009. See note 3 for attendance statistics.

17. Graham et al., 243-251. In my own evaluations, both views have been expressed. One complained that the instructor should "just lecture and hold me responsible for the material." More common is the sentiment that clickers were "cool" because they made class "interactive rather than just lecture." "The majority of class is allowed [to participate]," another noted, "and likes to be involved."

18. Evaluation in possession of the author.