

USING CLICKER TECHNOLOGY TO EXPAND THE ROLES OF EDUCATOR AND STUDENT

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Abstract

Audience response systems (clicker technology) are embraced in higher education as a pedagogical tool to emphasize inquiry, dialogue, and debate in the Socratic tradition; as a formative tool to provide immediate feedback on concept attainment; and as a classroom management tool to encourage student engagement and monitor student performance. Such use prompts instructors to rethink their role, lecturing less and providing more opportunities for group problem-solving. It also prompts students to rethink their role, reflecting on concept attainment, acknowledging diverse viewpoints, and becoming more active learners. This presentation will discuss implementation at The University of Akron and share best practices.

Introduction

Institutions of learning are embracing audience response systems (clicker technology) for multiple reasons related to concept attainment and classroom management. With this technology, instructors can combine lecture with embedded questions that allow students to select or type in a response and send it electronically to a receiver attached to the instructor's computer. Results are immediately available to the instructor and can be displayed to the class as well either as percentages or in a variety of graphic formats, the most commonly used being a histogram.

Clicker technology enhances education by enabling a more active, learner-centered environment and offering benefits to instructor and student.

As a tool to assist instructors, a response system can provide immediate feedback on concepts students have mastered or are struggling with, permitting just-in-time intervention before exams and allowing for formative rather than merely summative assessment. In addition, it can be helpful in managing the classroom (e.g., noting attendance in very large classes), in encouraging student engagement, and in monitoring the performance of individual students. The most successful instructors are prompted to rethink their own role, lecturing less and providing more opportunities for group problem solving and discussion.

As a tool to assist students, a response system can provide a forum for anonymous answers, so every voice can be 'heard' even when the question is sensitive, the correct answer is not obvious, or the student is shy. With right or wrong questions, students become better aware of their progress and therefore their own need to review certain material. When questions relate to opinions with no right or wrong answer, students (and faculty) can be exposed to diverse viewpoints that lift them out of their own world view and encourage them to objectively acknowledge their own underlying assumptions. The most successful students are prompted to rethink their own role, becoming less like an empty container to be filled and more responsible for their own learning.

In addition, clickers can enhance the functioning of administrative units, e.g., for training, and can also be used to support special events. The emergence of virtual clicker systems offers both increased access and increased challenges in terms of classroom management.

Pilot Implementation at The University of Akron

The University of Akron (UA) piloted this technology in 2004 through an internal grant administered by two academic organizations that reported directly to the Provost: the Center for Collaboration & Inquiry and the Institute for Teaching and Learning. Faculty were invited to submit proposals outlining how they would use the clickers in class, and 45 faculty in 23 departments from 8 colleges were chosen for funding.

Funded faculty received a stipend in addition to their regular salary. Each received an eInstruction Classroom Performance System (CPS) receiver and clicker set using infrared technology that required students to aim their clickers directly at a receiver. Faculty were trained to use the technology and to develop questions that went beyond a simple right-or-wrong answer and instead encouraged critical thinking and collaboration through the use of ConcepTests (Mazur, 1997). In this method, students answer individually, then discuss their answers with others, and finally answer the same question again without any intervening instructor lecture. This method encourages students to think through problems, make claims about their answers, provide evidence for their claims, and listen to others. Thus, they are not only actively engaged in thinking about the content but also in talking about it, allowing them practice in important communication and teamwork skills that the workforce demands.

Pilot faculty included instructors at every level of the curriculum, from developmental courses such as basic writing through courses taught at UA's School of Law. A paper survey was administered to each participating class and a separate survey to each participating instructor. There was no control group, so the results were based on participant self-report. Students ($n = 880$) and faculty ($n = 45$) believed CPS and ConcepTests had a positive effect on their experience and

would recommend clicker use in other courses (McConnell, 2005b). Based on their open-ended responses, students were most positive about improved concept attainment (37%), peer interaction (23%), and the opportunity for anonymous participation (13%). Faculty were asked to respond to a series of questions on a Likert scale of 1–5, with 1 indicating the most positive response. Their highest responses were to the statements “Easier to emphasize critical concepts” and “Helped determine student understanding,” both of which were rated 1.57. While generally positive about clickers, many also mentioned the challenges of the infrared technology, particularly in large classes.

A Scalable Technology: Continuing Implementation

Once the initial pilot was completed, faculty were no longer compensated for implementing the technology and students were expected to pay for their own clickers. However, due to UA’s annual license with eInstruction students do not have to pay to register their clickers for each class using clickers during a semester. In addition, the move to radio frequency systems simplified use.

As a result of academic reorganization, the Center for Collaboration and Inquiry was disbanded and administration of the program moved to Design and Development Services (DDS), which reports to the Vice President of Information Technology and Chief Information Officer. Other learning technologies supported by Design and Development Services include UA’s learning management system, web-conferencing system, and lecture capture system. Moving support to IT could affect the way faculty viewed the technology, and therefore training, offered by DDS, continued to be sponsored by the Institute for Teaching and Learning.

UA is in its seventh year of standardized use of an audience response system for classes and special events, with total (non-unique) enrollment of 9384 in credit classes using clickers in 2010, up 8% from 2009. In addition, a growing number of administrative units have purchased sets of clickers to use for training and other purposes, and Design and Development Services is frequently called upon to provide sets for special events.

Conceptual Framework: Clickers as a Pedagogical Tool

Clicker technology is one way to effect educational goals through methods that have been recognized since the time of Socrates. The Socratic method emphasizes inquiry, dialogue, and debate as opposed to lecture and memorization. Accounts of Socrates’ dialogues demonstrate a method based on asking and answering questions, a method that encourages critical thinking and ownership of learning. This method itself is articulated by Socrates in Xenophon’s *The Economist*:

I am disposed to ask: “Does teaching consist in putting questions?” . . .
You lead me through the field of my own knowledge, and then by
pointing out analogies to what I know, persuade me that I really know
some things which hitherto, as I believed, I had no knowledge of.

Appropriate questioning allows discourse participants to make their own connections to prior knowledge and arrive at new conclusions. Socrates’ ideas infuse the works of contemporary educational philosophers. American educator John Dewey claims “The only true education comes through the stimulation of the child’s powers by the demands of social situations in which he finds himself” (1897, p. 3). Similarly, Piaget’s notion of constructivism (1957) holds that individuals construct new knowledge from their experiences, including social experiences. The Brazilian educational philosopher Paulo Freire criticizes theories of education that hold “Knowledge is a gift bestowed by those who consider themselves knowledgeable upon those whom they consider to know nothing” (1970/2000, p. 72) and consider students empty buckets waiting to be filled. He argues instead that education emerges through dialogue between teacher and student and that “the problem-posing educator constantly re-forms his reflections in the reflection of the students” (p. 80).

In a world where the body of knowledge is constantly growing, driven in many ways by the exploding development of new technologies, today’s students cannot be satisfied with memorizing facts that might be outdated tomorrow. Instead, they need to prepare themselves to be lifelong learners, constantly observing, analyzing, and reflecting upon their world and constantly constructing new knowledge through their interactions with their environment and each other. And their instructors need to do the same. Such an approach to education aligns well with the use of clicker technology. The “sage on the stage” is replaced with the “guide on the side” (King, 1993) who combines traditional lecture techniques with clicker questions. By posing questions that emphasize inquiry, dialogue, and debate, instructors serve students better than through lecture and rote assessment. These questions prompt instructors and students to rethink their traditional roles and embrace opportunities for collaborative learning.

Clickers as a Tool for Classroom Management

When used within an appropriate theoretical model that encourages student reflection and dialogue with peers, clicker use offers many advantages to instructors in terms of classroom management and engagement. Using clickers requires an investment of time both to learn how to use the technology seamlessly and to set the system up before each class. The faculty who choose to use them semester after semester acknowledge that the benefits, outlined below, outweigh these costs.

Formative and Summative Assessment

Faculty can assess student attitudes and comprehension or difficulty with material, providing just-in-time intervention. It can be somewhat humbling to congratulate yourself on a brilliant lesson and then discover that half your students incorrectly answer a clicker question designed to assess their mastery of the targeted concept. However, it is far better to have this happen before the exam that will constitute a large part of their grade. Discovery of student difficulty can prompt multiple interventions, including small-group problem-solving activities, whole class discussion, additional reading, and even additional assignments. Mazur's use of peer instruction can be particularly helpful: after students individually answer a question, they spend 2–3 minutes reaching consensus in small groups, forcing them to think through their reasoning and provide evidence for their response. The same question is then asked again, and, typically, correct answers increase the second time along with student confidence. Such activities encourage each student to participate actively and help them uncover for themselves gaps in their understanding. In addition, the questioning provides them with practice for subsequent 'higher stakes' assignments or exams.

Increased Student Engagement, Resulting in a More *Attentive* Class

In 1976, A. H. Johnstone and F. Percival observed breaks in attention of college students in chemistry lectures and reported that after an initial "settling down" period, "the next lapse of attention usually occurred some 10 to 18 minutes later, and as the lecture proceeded the attention span became shorter and often fell to three or four minutes towards the end of a standard lecture." Use of clicker technology may serve to 'reset the clock' by engaging students in both the cognitive activity of contemplating a question *and* the physical activity of committing to a response; in many cases, they may also be engaged in discussion with peers before or after voting. The research of Bunce et al. (2010) corroborates Johnstone and Percival's results with respect to the shortening cycles of attention; they further found that use of clicker questions "resulted in significantly lower self-reported student attention decline than lecture."

Increased Student Engagement, Resulting in a More *Interactive* Class

In the pilot UA clicker study, students largely agreed with the statement that use of clickers increased their willingness to respond to questions in class. This was corroborated in a subsequent study conducted by DDS: 68% of 463 clicker users that voluntarily responded to an online survey indicated their increased willingness to answer questions, and 30% further indicated they were more likely to ask questions in and out of class. In other words, clickers can help create an environment that not only encourages students to respond to questions and then engage in dialogue about those responses, but also ask questions that could be crucial to their success and contribute to a more interactive classroom environment. Responses to questions can also be used to generate further discussion and exploration.

Monitoring of Class and Individual Student Performance

Reporting features built in to the clicker software allow instructors to review session results in multiple ways. When correct answers are noted, instructors can note overall class performance as well as performance on individual questions or by individual students. With a built-in grading feature, it is also possible to give students points for correct answers, or points for any answer, thus rewarding them for participation even if their answer is incorrect. Such review can inform the focus for future lectures or allow instructors to recommend additional help for students who appear to be struggling. It is possible to view reports as a cross tab of individual questions, allowing analysis by student demographic features or by responses to particular questions. It is also possible to generate attendance from a clicker session, which can be particularly helpful when there are several hundred students in the class. (It should not, however, be used merely to take attendance. Students resent having to pay for a clicker that offers them no educational benefit and perceive faculty who use them only for this purpose as being lazy.) Grades can be exported in various formats in order to integrate with a learning management system or for archiving.

Clickers as a Tool for Student Reflection and Action

Freire held that the ultimate goal of education is empowering students to practice “reflection and action upon the world in order to transform it” (2000, p. 51). Clicker technology provides a vehicle for students to practice both.

Active, Collaborative Learning

While in training faculty assume that the feature students value most highly is the opportunity for anonymous responses, in fact what they seem to value most is the ability of clicker technology to enhance their learning. Donovan (2008) found that students demonstrated better performance on chemistry exam questions that included concepts that were specifically practiced in similar — but not identical — clicker questions. In the DDS study, 64% of students strongly agreed or agreed that use “reinforced important concepts” and 60% strongly agreed or agreed that it “helped me measure my level of understanding.” Open-ended responses, quoted below, reveal student insight into the teaching/learning process:

- It allows the instructor to understand how much the class knows in a matter of seconds, so the instructor can focus on the material that is not fully understood and skim the material the majority of the class understands.
- It encouraged student discussions.
- It is a fun, interactive way to learn.
- I appreciate the ability to see where I am and what my weaknesses are.
- I think it helped a lot because people don't normally want to speak.

Peer Interaction

According to the 2010 National Survey of Student Engagement, “students who learned in interactions with their peers were more likely to participate in other effective educational practices and had more positive views of the campus learning environment” (p. 19). Particularly in the first few months, small-group, face-to-face interactions are “a significant socializing vehicle” for commuter students (Krause, 2007). These findings are especially important in the United States as state subsidies increase for each year a student stays in school, making retention economically as well as academically important. Thus, the opportunity for peer interaction introduced by clicker use can have positive effects not only on course content but also on student attitudes toward their educational experience and as a result on their retention.

A second advantage of peer interaction as motivated by clicker use is the opportunity for students to solve problems as a team. According to the National Association of Colleges and Employers, two of the top five employee qualities in a 2011 survey of employers included “communication skills” and “teamwork skills.” Strategies that include asking students to share viewpoints and reach consensus as a group have benefits that reach beyond the classroom.

Anonymous Responses

Some students find it easier to voice their opinions in a large class. Clickers give even shy students a voice by making their contribution anonymous. Students can respond without fear if they are not confident about the “right” answer and be validated if they are correct or reassured that they are not the only ones that got it wrong. Students can also respond without concern if the question is sensitive or a response could reveal group membership or affiliation (instructors can mask student identify for such responses so they are truly anonymous). In fact, Miller (2009) asked basic writing students to devise metaphors for their use of clickers; one responded the clicker was like “a brick wall. Because the wall that is there allows me not to be seen when I give and [sic] answer” (p. 204).

Exposure to Diverse Viewpoints

Just as faculty are sometimes surprised by what they discover students do not understand students can be surprised by seeing a range of responses to questions that they consider obvious. Survey questions with no right or wrong answer can reveal a multiplicity of opinions that can also reveal diverse underlying assumptions about the world. Exposure to such diverse viewpoints can lift students out of their own worldview, encourage them to reflect and objectively acknowledge their own underlying assumptions, and, optimally, lead them to respect or at least acknowledge the opinions of classmates. Faculty can use diverse responses as a springboard for discussion, e.g., asking proponents of different viewpoints to discuss their choices and then exploring the reasons behind those choices. Such exposure to differing viewpoints can also help students better communicate with a diverse audience, as Miller found with her basic writing students (2009, p. 194).

Better Learning Outcomes

As a happy corollary to increased engagement, studies report that students achieve greater success in courses that use clickers. Poulis et al. (1998) report that in physics courses student pass rates increased from 55% to over 80% when response systems were combined with student discussion. Greer and Heaney (2004) note that attendance in large introductory geology courses doubled after the introduction of response systems. In the UA pilot study, Donovan (as cited by McConnell, 2005a) reports that students receiving a grade of D or F or withdrawing decreased when clickers were introduced. Similarly, El-Rady (2006) reports that exam scores in a non-major biology course improved with response systems, likely because classroom voting helped students to stay focused. Radosevich et al. (2008) note that organizational behavior clicker users not only demonstrated higher scores and greater retention but also greater self-assessed engagement and interest.

Clickers as a Tool for Administrative Units and Special Events

While classroom adoption at UA has been fairly steady the past few years, administrative use continually increases. For example, the office of New Student Orientation uses clickers at every orientation; Student Judicial Affairs uses them for training of administrators and students; Multicultural Development uses them when invited to visit sections of Student Success Seminar. DDS is also asked to support their use at special events, e.g., conferences, competitions, and presentations for groups as large as 500. As more faculty and administrators observe the use of clickers at such functions, there are more requests for new and novel applications, and such use helps integrate the technology into the university culture.

Supporting the Clicker Culture: Implementation and Assessment

Implementation is largely about “creating a culture of clickers” on campus. Both training and support need to be available. At UA, DDS formally offers training through the Institute for Teaching and Learning but also responds to college or departmental requests to offer training for specific faculty. When asked, a DDS representative is available for the first day of class to assist with start up and troubleshoot clicker registration and joining issues. DDS personnel have shared personal cell phone numbers so faculty can call in the event of difficulty during class (usually, the problem can be solved over the phone; someone meets them in their classroom). The goal is always to guide instructors in making use of the technology to enhance their teaching/learning outcomes so that they can convey their content as effectively as possible. Some faculty have expressed reservations

about using clickers because: they can't be assured they will have a tech-enhanced classroom; they do not want to ask the students to assume an additional cost; they do not want to invest time in learning the technology; they do not want to take away from class lecture time. While some concerns remain valid, the growing body of research on student engagement in general and clicker use in particular will hopefully motivate those concerned about losing lecture time to try this alternate, transforming activity.

The initial pilot assessment was not anonymous since instructors were compensated and students received their infrared clickers for free. The follow-up DDS study was offered anonymously through an online survey, interestingly enough the same semester clickers with an LCD screen became available. Student response was generally positive, but students with the older non-LCD clickers reported more technology problems and more dissatisfaction than those with the newer clickers. Results suggest that despite pedagogical benefits, any educational technology needs to be reliable and easy in order to keep users happy.

In addition to this quantitative evidence, DDS gathers qualitative evidence by maintaining open lines with faculty and student users. Student kudos or complaints inform best practices that are shared with faculty users.

Future Directions

The University of Akron has arrived at another crossroads in implementation and support: the availability of virtual clicker systems that allow students to use wireless mobile devices for response. Currently, such devices would not be interoperable with the system in use at UA, and therefore alternatives are being evaluated. Students have already indicated they would welcome the opportunity to use a laptop or cell phone instead of a purchased clicker. Virtual technology would also enable real-time participation by distance learning students (attending at a connected distance learning class or through a desktop connection). It might also be possible to use this technology for polling by asynchronous online classes. At the same time, faculty have expressed some concerns about the likelihood of student distraction with vehicles for e-mail or Facebook so close at hand. It is clear that faculty attitudes towards virtual devices must be assessed before committing to a change. In addition, the financial aspects of licensing options that include a virtual system must also be considered.

Conclusion

Clickers are a transforming educational technology. They prompt both instructors and students to rethink their traditional roles with respect to 'giving' and 'receiving' content. As a result, they effect a more interactive, collaborative

teaching and learning environment that not only recognizes diversity in background and opinion but also better prepares participants to respond to it. Improved concept attainment and increased engagement in learning through the use of clickers can lead to higher grades and greater retention. While implementation of an audience response system involves cost in terms of licensing and time commitment of IT staff and faculty, the documented benefits to instructors and students, and their overtly expressed satisfaction, continue to make this a promising technology for both in and out of the classroom.

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