Student Response Systems ("Clickers") in the Psychology Classroom:

A Beginner's Guide

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Introduction

The purpose of this guide is to help lower barriers for instructors who are interested in using student response systems, or "clickers," but are intimidated by the technology or the time investment. This guide is a step-by-step overview of the process of adopting clickers based on my experiences as a professor who recently took the plunge. In order to continue to learn more after reviewing the basics presented in this document, I suggest exploring the more advanced materials listed in Appendix A (p. 18). The following is a list of the major steps that are detailed in subsequent sections of this guide:

Clicker Uses

Clickers are handheld devices resembling television remote controls that students use to answer multiple choice questions during class time. Students' answers are collected by the instructor's computer through a portable receiver, typically plugged into a USB port. The instructor can a priori determine whether answers are anonymous or are entered into a database with a class roster for the purpose of assigning grades. Once

received by the computer, students' responses can then be displayed in a bar graph to reveal the distribution of responses. Color-coding may be used to reveal the correct answer.

Attendance. Instructors of large classes, in particular, may like the ability to quickly and easily monitor attendance throughout the class period, perhaps at the beginning, middle, and end with point values assigned to each in order to reward arriving promptly and staying through the duration of the class. Some evidence suggests that clickers increase attendance and decrease attrition rates (Burnstein & Lederman, 2001; Lopez-Herrejon & Schulman, 2004; Owens et al., 2004).

Anonymous data collection. Because clicker data may be collected anonymously, instructors can use clickers to ask students their opinions, even regarding sensitive topics. In large introductory psychology classes, Poirier and Feldman (2007) use clickers to measure students' attitudes or opinions about controversial topics, such as the ethics of animal research. To bring research to life, Cleary (2008) describes using clickers as anonymous data collection tools that assist in-class replication of known behavioral research findings, such as the false memory effect.

Testing. Instructors may also use clickers for in-class testing with multiple choice questions. Instructors can give students standard printed test questions and use a special clicker setting that records students' answers in a database for easy grading with potentially fewer opportunities for cheating by glancing at a neighbor's paper. With shorter quizzes, the instructor may use computer projection to display the questions that students then answer with the clicker. Morling, McAuliffe, Cohen, and DiLorenzo (2008) used clickers to administer five, extra-credit multiple choice questions based on the day's

reading assignment in two large (N = ~320) sections of introductory psychology. At the end of these class periods, the instructor elaborated on one of the original questions. When Morling et al. (2008) compared exam grades in these classes with exam grades in comparable sections that did not use the clickers, they found a significantly higher exam score in the clicker sections on only one of four exams; the greatest between group difference in exam scores was 2.99% (69.44% vs. 72.43%) and the smallest was 0.58% (69.04% vs. 69.62%). This research offers only modest support for the use of clickers in administering in-class reading quizzes. Research from natural sciences suggests potential problems with using clickers for testing, such as the lack of a paper trail for disputing answers and the possibility for cheating when a student brings another's clicker to class (Herreid, 2006). Another potential pitfall occurs when students' clickers do not work; they cannot respond to the test questions.

ConcepTests. Aforementioned techniques save paper and may promote desirable behaviors, such as increased attendance and textbook reading; however, they do not fundamentally change how learning occurs in the classroom. To change the intensity of classroom learning, incorporate clickers into the lecture. With effort and practice using effective active learning techniques paired with clickers, an instructor can transform a traditional, passive lecture into an active learning environment. Although psychology instructors are beginning to use lectures with embedded clicker questions in their classrooms with modest success (Poirier & Feldman, 2007), college physics education is ahead of the curve. Harvard physicist, Eric Mazur (1997), developed and tested a peer instruction technique, known as ConcepTests (based on Lyman's, 1981, "think-pair-share" system), that is empirically supported (e.g., Crouch & Mazur, 2001) and lends

itself well to use with the clicker. ConcepTests are conceptual multiple choice questions given periodically (Mazur, 1997, suggests every 10 min) throughout the class period. The standard sequence consists of the following: (a) have students use their clickers to answer a question without revealing the correct response, (b) instruct students to debate with their neighbors why they think they selected the correct answer, (c) have a second round of student responses to the original question, (d) reveal the distribution of responses to determine if there has been a change, and (e) have the class discuss the correct answer.

One of the likely benefits of the ConcepTest approach is that it leads to greater depth in students' discussion and thinking. In a large survey of faculty using clickers at the University of Colorado-Boulder, Keller et al. (2007) found that students' opinions about clickers are more favorable when they lead to greater discussion in class by a higher number of students. Creating questions that promote a discussion format is likely one of the greater challenges of successful clicker use. Mazur (1997) recommends five basic criteria for ConcepTest questions: they should (a) focus on a single concept (to help the instructor isolate students' learning of concepts), (b) not be readily solvable by relying on equations, (c) have adequate multiple choice options (distracters that are common misconceptions), (d) be unambiguously worded, and (e) be neither too easy nor too difficult (50-80% accuracy is preferable). Ideally, questions trigger students' misconceptions about a concept, and the process of the ConcepTest helps challenge that misconception and replace it with a more accurate and deeper understanding (Mazur, 1997).

Chew (2004) lays the groundwork for applying ConcepTests to the introductory psychology classroom, emphasizing the importance of asking questions that entice

students to answer based on their misconception. The following is an example question he provides:

> A marriage counselor studies four different tests designed to predict marital happiness to see which one is best. She administers the four tests to 80 couples who are about to get married. After two years, she measures the marital happiness of the couples and correlates it with each of the four tests with the following results:
>
> Test 1: $r = -.73$ Test 2: $r = .62$
>
> Test 3: $r = .25$ Test 4: $r = .10$
>
> If the therapist wanted to pick the single best test to use in her work, which one should she choose and why? (p. 10)

Chew (2004) underscores that the quality of this ConcepTest lies in how it addresses the common student misconception that positive correlations are always stronger than negative ones. He further notes that instructors frequently lecture about such misconceptions, yet students persistently answer related test questions incorrectly. The ConcepTest procedure is designed to more effectively challenge and correct these misconceptions.

Clickers or Flash Cards?

Adopting any new teaching technique, especially those that involve technology, requires a commitment of resources including time and money. Incorporating clickers into the classroom may include time consuming negotiations with textbook representatives or clicker vendors, web-based (e.g., www.WebEx.com) or face-to-face software training, solo software practice, clicker question development, in-class practice

with the tools, and database management if responses are graded or otherwise analyzed. For instructors who choose to purchase a set of clickers, dollar costs can be in the thousands. If students are required to purchase their own clickers, costs to them typically range from $20 to $40.

Given this commitment, a potential user should ask "Are clickers worthwhile?" This is a particularly important question when research suggests that adding clickers to an active learning technique (e.g., cooperative quizzing, peer interaction, or ConcepTests typically administered with flash cards), does not lead to additional gains in learning beyond those gained by the active learning technique alone (Byrd, Coleman, & Werneth, 2004; Lasry, 2008). A set of five cards of different colors in the hands of each student will allow a class to respond to multiple choice question as quickly as using a personal response device. It is tempting to argue from such research that clickers are not worth the resources they require. However, some evidence suggests that clickers lead to greater positive emotion during lectures and more honesty in responses when compared with flash cards (Stowell & Nelson, 2007) because individual clicker responses are invisible to other students. There are reports of modest increases in exam grades when instructors use clickers to test concepts and probe opinions in large sections of introductory psychology (Poirier & Feldman, 2007). Furthermore, when Lasry (2008) failed to find any additional learning benefit from clickers over standard flash cards, he outlined three reasons for encouraging clicker use despite this null finding: (a) they encourage faculty to reexamine and reinvent their teaching methods, including adopting empirically supported active learning techniques, (b) clickers collect data that can be used for research as well as the cultivation of more effective questions, and (c) they promote in-class discussions by

allowing instructors to identify more easily and pair students with opposing conceptions. Class clicker responses may be presented graphically to the class in seconds. Therefore, an alternative conclusion from this research is that active learning techniques, such as Mazur's (1997) ConcepTests, increase learning, and the use of clickers encourages instructors to use these effective pedagogical strategies and offers the additional benefit over flash cards of easy data collection, thus promoting improved usage over time.

Instructors of large classes (e.g., those over 100 students) are often drawn to clickers because of challenges inherent to large classes, such as difficulty taking attendance and engaging a high percentage of students in class discussion. However, it can be argued that any class in excess of 10 students presents similar challenges. Students inhibit asking questions to allow others a turn, and instructors do not have time to gauge and adequately respond to individual student needs. Therefore, when used correctly, clickers may enhance active learning in almost all undergraduate classes by allowing for real-time assessment of learning and by facilitating peer instruction.

The literature across disciplines gives mixed but generally promising results concerning the use of clickers. In general, students report having favorable opinions about the use of clickers in their classes (Poirier & Feldman, 2007), especially in classes where the instructor encourages discussion and a large fraction of students report participating in these discussions (Keller et al., 2007).

Research on the use of clickers in psychology classrooms has just begun to emerge. In general, these studies report modest and variable effects of clickers on learning. For instance, Poirier and Feldman (2007) found a significant difference in final exam performance with higher scores in an introductory psychology course that used

clickers in a weekly activity in comparison to a comparable class that did not use the clickers. Two examples of weekly clicker activities included (a) asking one to three questions to test knowledge learned after presentation of a concept, and (b) measuring students' attitudes or opinions before and after a concept was presented. Although exam score differences were statistically significant, the difference was only 1.31 points (84.03 vs. 82.72) with a small effect size (Cohen's d = .17).

Instructors exploring the use of clickers should consider the following questions:

1) Am I committed to using active learning techniques, such as ConcepTests, and encouraging discussion among my students (Chew, 2004; Mazur, 1997)?
2) Given the previously discussed findings of Byrd et al. (2004) and Lasry (2008), do my students or department have the financial means to justify using clickers instead of flash cards?
3) Am I committed to learning new software and working with technical support staff to work through problems?
4) Because the effectiveness of clicker use, like many skills, seems to increase with instructor's experience, am I committed to honing my clicker skills by teaching the same class regularly over a period of years (Duncan, 2005)?

Choosing a Vendor and Plan

Instructors have three main options when selecting a clicker system: (a) using a system adopted campus-wide, (b) purchasing a set of clickers to pass out and collect during class time, or (c) requiring students to purchase a clicker from the bookstore. Questions to consider when selecting a plan of action include

1) Has my university made a universal adoption of a specific clicker system?

2) Does my department have the funds to purchase a bag of clickers for my classes, or should I require my students to make the purchase?
3) Are any other instructors on campus using clickers, and if so, which vendors are they using?
4) Does my textbook publisher offer a cost-saving clicker plans?

If your campus has adopted a specific clicker system, the decision about which vendor to select has been made for you. When a university makes a universal adoption, students are able to use their clickers across multiple classes (clicker systems are not interchangeable), dramatically lowering the cost per class. Having a standard clicker system also promotes collaboration among users across campus. To move towards a campus adoption, if one does not yet exist, faculty within departments or colleges may want to first initiate an adoption on this level. To find out whether your campus has made an adoption, ask your bookstore.

If your university has not made an institutional commitment, instructors have two major options remaining. The first is for individual instructors to purchase a set of clickers directly from a clicker vendor, generally for a few thousand dollars depending on the number of clickers required (see Appendix B, p. 19, for a sample of vendors). This option may be preferable, provided a department has the necessary funds, if clickers are not widely used on a campus (which makes it less likely that a student will be able to use their clickers beyond a single class), or if students have limited means. An advantage of this approach is that it enables the instructor to have control over the clicker, such that clickers cannot be forgotten or lost and are less likely to be seriously damaged. It also increases the likelihood that all students will have access to a clicker, rather than just

those who choose to or are able to purchase it. A disadvantage of this approach is that clicker technology is rapidly changing, so one's purchased set may be obsolete in a few semesters. It may also be time consuming for clickers to be passed out and collected at the beginning and end of each class period.

The final option is to arrange for students to purchase clickers at the university bookstore. This option requires the instructor to select a clicker vendor, system, and payment plan. In making this selection, the instructor will want to consult with the university bookstore to determine whether other instructors on campus are using clickers, and if so, with what vendor(s). In order to maximize the use students get out of a clicker, it is preferable to use a single vendor across campus, or at least in a college or department. If clickers are not in use on campus, textbook representatives may be able to provide information about special cost saving plans. Most textbook publishers have partnered with a student response system vendor, resulting in discounted clicker plans for textbook adopters and their students. Publishers and clicker vendors differ with regard to the specific type of plans they offer. Some require students to purchase the clicker from the bookstore and then pay an additional per-semester fee online to register the clicker. Others require students to pay a single, generally higher fee with no additional registration cost. Textbook representatives should be able to provide details about the clicker plan they offer. When pricing clickers, instructors should be aware of the two main types of clickers: radio frequency (RF) and infrared (IR). Radio frequency clickers are likely to be more expensive but more reliable, particularly in a larger classroom. Infrared clickers, like a television remote control, may have their signal blocked by physical barriers that stand between the clicker and the receiver.

In addition to considering price differences, instructors should also inquire about the ancillary materials (e.g., premade clicker questions) and technical support textbook publishers offer, as the ease these features give to the instructor may outweigh the burden of extra costs to students. One should also inquire about the cost of receivers and the clicker software; both of these are often free to adopters.

Learning the Software

If you select a clicker system in partnership with a textbook publisher, ask a textbook representative to arrange a training session on the clicker software, either face-to-face or a web-based conference. Technical support staff commonly travel to a university to deliver such training. Most clicker software is a free download from the vendor's website, and many websites provide additional resources such as manuals or tutorials. When adopting a system, the instructor should receive contact information for support staff from both the clicker vendor and the publisher.

Most clicker software is user friendly. Many companies offer the option of using software that enhances one's projected slides so that questions may be typed and displayed within a PowerPoint™ presentation. Other options allow instructors to present freestanding clicker questions independent of other tools.

Standard features of software include multiple choice question displays, programmable timers to limit response time, bar graph displays of answers (accuracy may be color coded), anonymous response options, and a database for storing and managing student responses.

Preparing Students and the Classroom

Once one has become familiar with the clicker software, prepared the questions either in the PowerPoint™ presentation or independently, and practiced administering questions, bringing the system to life in the classroom is relatively simple. The software must be properly installed on the computer (installation of even free software usually requires the university's computer support staff), the receiver must be plugged into the instructor's computer (most use a USB port), the instructor must properly set up the database for storing student responses (instructions for this should be provided during the software training), and students must purchase and bring to class their clickers (many clickers must also be registered online before they can be used in class). To help speed up the student registration process, instructors may consider e-mailing students instructions about the clicker purchasing and registration process, an electronic copy of which should be provided by the clicker vendor. Such instructions should also be displayed in the course syllabus.

In addition to achieving these basics, Duncan (2005) emphasizes the importance of communicating to students the potential benefits of clickers. Active learning places a greater demand on students than standard, passive, note-taking. Clickers are also an additional expense. Therefore, students may have an unfavorable view of clickers unless instructors communicate their advantages.

Developing Best Practices

As reviewed earlier, the effects of clickers on learning are not well understood, particularly in psychology courses. Research generally suggests that clickers alone do not increase learning beyond the active learning techniques they are used to implement. However, they may make implementation of certain empirically supported, active

learning techniques easier and more efficient. To better understand which clicker-based active learning techniques are most effective, more research is needed. Instructors who choose to incorporate clickers into their classes should consider adding to the literature. Such research should measure and accordingly control for the quality of the students in the different sections (e.g., using standardized test scores or grade point averages), employ empirically supported or previously untested active learning techniques, and broaden the range of learning outcome measures beyond exams (e.g., multiple choice vs. short answer question performance, standardized psychology tests). Pretesting and posttesting across control and experimental sections will allow researchers to compare gains in learning associated with clickers used in support of specific pedagogical strategies.

Duncan's (2005) report that clicker use becomes more effective with instructor's experience should encourage new users to persevere despite initial suboptimal outcomes. With more research, collaboration, creativity, and technological innovations, the effectiveness of clicker-based techniques should steadily improve.

Conclusion

Although research examining the effect of clickers on learning is variable, it is apparent that clickers are a tool for promoting empirically supported active learning in the classroom. Thus, if clickers do not directly increase learning, then they are likely to do so indirectly by promoting the use of learning techniques that do. When used thoughtfully, rather than merely for taking attendance, clickers have the potential to help transform undergraduate education and education research. New users should form working relationships with their textbook representatives, their clicker support staff, as

well as colleagues on campus and afar who are eager to maximize learning in the classroom. With support, it is relatively easy to incorporate clickers into the classroom, and the benefits will continue to grow.

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Appendix A:

Other Resources

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Appendix B:

Student Response System Vendors

Audience Response Systems. http://www.audienceresponse.com/

Classroom Clickers. www.iRespond.com/

Classroom Performance System (CPS). http://www.einstruction.com/

H-ITT Classroom Response System. http://www.h-itt.com/

iClicker. http://www.iclicker.com

Qwizdom Response System. http://www.qwizdom.com/

SmartRoom. http://www.smartroom.com/

TurningPoint. http://www.turningtechnologies.com