Using Personal Response Systems in Large Classes


Research universities such as MSU, are rich in both technological innovation and creative scholarship, making them uniquely situated to produce the tools and practices that will best achieve positive outcomes. Disappointingly, the manner in which technology has been implemented by educators has been fairly narrow. Brewer (2004) showed that 138 University of Montana faculty restricted their course-related use of computers and technology to administrative functions, e.g., for posting syllabi (93.8%), class assignments (79.7%), web links (71.9%), readings (68.8%), and lecture notes (62.5%). Fewer than 10% reported using technology in their classroom to promote student interaction or as a means of collecting formative assessment data.

One of the most recent technological innovations to achieve broad usership in college classrooms is the personalized electronic response system, also known as “clickers”. Competition among leading vendors (e.g., Personal Response System (PRS), http://www.gtcocalcomp.com; Classroom Performance System (CPS), http://www.einstruction.com; and Hyper-Interactive Teaching Technology Classroom Response System (HITT), http://www.ablongman.com/) has led these companies to begin combining forces with textbook publishers to offer student discounts on transmitters, free software for faculty, and pre-packaged “ready-to-use” questions to further promote usage.

It is our premise that one of the greatest potential contributions of in-class technological tools, such as clickers, is in bridging the disconnect between teacher and student in large lecture settings. Feedback from students using clickers provides formative assessment data about student understanding that can be “seen” by both faculty and students. Many students will not ordinarily contribute to class discussion for fear of being “exposed” to their peers or to the instructor. Answering questions with clickers ensures that all students contribute to the answering process with equal representation, rather than just the highly motivated and extroverted minority. This engages students as active participants in the learning process with the security of anonymity. Visible, real-time data enable faculty to make informed decisions about the direction of instruction so that students’ perceptions or misunderstandings can be addressed. Changing the course of instruction to deal with misunderstandings coveys to students that faculty are working in a direction to help them achieve as learners, thus fostering a greater sense of interpersonal interaction and community in the classroom.

Informal discussions with our colleagues on campus and elsewhere reveal that many faculty feel compelled to use this technology in their courses, but are uncertain about how to integrate it effectively. As one colleague recently stated, “It came bundled with a very expensive text – I just feel like I needed to use the thing, but I have no idea why or how.” Another expressed near disgust with the devices for their lack of reliability and for “the time I waste in lecture when I can accomplish the same thing more efficiently on paper or on-line quizzing.” Several faculty indicate that they use it for testing students’ fluency with biological jargon and for definitional questions – a strategy reflected in the types of questions provided in textbook question banks developed for clickers.

It is our contention that many of the approaches used by faculty adopting clickers are not realizing the potential value of clickers as tools for improving learning or for acquiring formative assessment data that can be used to inform teaching. We argue that one of the most powerful features of the clicker technology is in the ability to generate real-time feedback about student understanding that can inform the direction of instruction – and this cannot be accomplished in an equivalent fashion with paper or on-line quizzing. Further, we hypothesize that one of the strongest predictors of learning gains that can be achieved with clicker-adapted peer-instruction (PI) lies in the quality of conceptual questions used in PI sessions. Low-level, knowledge-based questions such as testing vocabulary definitions, may be an appropriate goal for science-based courses rich in jargon. However, we would not consider these the most learning-effective use of clicker technology, nor would we expect such questions to stimulate content- and concept-rich discussions in PI sessions.
Our Peer Instruction Model: Use of clickers in three introductory biology courses

**Pretest:** Pretest questions are administered either at the beginning of the course or prior to beginning a unit of instruction to: 1) probe pre-instruction knowledge, 2) engage students in material coming in the next unit of instruction, and 3) provide the baseline assessment against which learning gains will be measured.

**Instruction:** The instructor spends 7 – 15 minutes exploring a new concept and related content. Depending on the instructor's individual style and the particular topic, this may include an in-class activity, demonstration, discussion, and/or lecture presentation.

**Peer Instruction Session (Think – Pair):**
- **Step 1: Display Question and Wait.** The instructor displays a conceptual question to test understanding of instructional material. Students are given at least 1 full minute to consider the question (think) before the instructor opens the system for receiving answers submitted by students.
- **Step 2: Student Response 1.** Students submit their responses via clicker. While the question is open, students may change their answer as many times as they like, but they do not have the benefit of consulting with peers, nor do they receive feedback about their classmates’ responses during this time. The question is closed at the end of a predetermined time or after all responses have been confirmed.
- **Step 3: Display and Describe Results.** The clicker software generates histograms displaying an answer frequency distribution within 1 second of closing the question. The instructor describes the results verbally without interpretation. Note: In most cases, there will be a distribution of student responses across all or most answer options. However, in rare instances where 95% or more (or whatever percent is deemed suitable by the instructor) of the students respond correctly, it may be concluded that students are demonstrating mastery of the concept and there is no need to proceed with the rest of the PI session. Time will be better spent moving on to the next topic or next conceptual question.
- **Step 4: Group Discussion.** Students are given 2-4 min. to discuss and defend their answers in small groups. In courses taught by all three instructors, students work in permanent base groups of 4 students throughout the semester. Base groups are generally the unit of group discussion for PI sessions.
- **Step 5: Student Response 2.** The question is opened a second time and students submit answers. The question is closed after the allotted time has passed or after all responses are received.
- **Step 6: Display and Describe Results.** A second set of histograms shows the frequency distribution of post-discussion answers to the same question. The instructor describes the answer distribution and notes any significant changes between the first and second round of questioning, but does not indicate the “right” answer.

**Synthesis of PI Session (Share):** Students who changed their mind are called upon to volunteer explanations as to: 1) “why” they chose the answers they did individually, and 2) what arguments were presented within their groups that were most convincing in their decisions to change their answer. Students from other groups are encouraged to critique the arguments and to share other arguments that emerged within their group discussions. In many cases, students initiate the discussion by first providing explanations for why they were able to eliminate certain options even though they may be uncertain about the correct option. As the discussion unfolds, flaws in arguments for wrong answers usually become apparent and the remaining students converge on the correct answer with the benefit of explanation offered by their peers and validation from the instructor.

Depending on the percentage of correct responses following the second round of answers, instruction proceeds in one of 2 directions:

- **If the proportion of correct responses is high** and it is apparent that the majority of students understand the concept, instruction proceeds with the next lecture topic.
- **If the proportion of correct responses is low:** the instructor continues instruction on the same material by any method that seems appropriate. This may include additional lecture, opening a discussion, assigning a group task or problem, or pursuing another avenue to shed light on the concept that is posing difficulty. At the conclusion of that intervention, the instructor returns to the same (or an analogous) conceptual question and the PI session is repeated.
**Posttest**: Midterm and final exams will include analogs (or repeats) of pretest questions in order to test for overall learning gains and retention of concepts that showed positive gains during PI sessions. Additional assessments are described below that will reinforce our confidence in accurately measuring student learning gains.