STEM Subject: Miscellaneous

Moss, K., Crowley, M. 2011. Effective learning in science: The use of personal response systems with wide range of audiences. Computers & Education. Vol. 56, 36-43.

> This paper describes the flexibility of Personal Response Systems (PRSs), (also known as 'clickers' or electronic voting systems (EVS)), as part of strategies to support students' learning in science. Whilst variants of this technology began to appear 12 years ago, there is now a steadily increasing adoption of these systems within higher education, including science programmes, and this use has grown significantly in the last six years. They have previously been shown to offer a measurable learning benefit. Typically, someone at an institution buys these systems for learning support and they never make it out of their cases. Far less work has been done with these systems at school level. In this practitioner based paper, the broad range of practical uses for these systems is described in a variety of formal and informal learning situations – from testing the understanding of science concepts (from primary aged school children up to physics undergraduates), to undertaking evaluation of events as well as public participation in data collection for research on attitudes to careers. In addition, the data collected on such handsets can be mapped to demographic factors such as gender and age yielding further layers of analysis. Overall this is a highly flexible and transferable approach to the use of interactive technology for engaging learners of all ages as well as carrying out research.

Mayer, R.E., Stull, S., Deleeuw, K., Almeroth, K., Bimber, B., Chun, D., Bulger, M., Campbell, J., Knight, A., Zhang, H. 2009. Clickers in college classrooms: Fostering learning with questioning methods in large lecture classes. Contemporary Educational Psychology. Vol. 34, 51-57

> What can be done to promote student–instructor interaction in a large lecture class? One approach is to use a personal response system (or ''clickers") in which students press a button on a hand-held remote control device corresponding to their answer to a multiple choice question projected on a screen, then see the class distribution of answers on a screen, and discuss the thinking that leads to the correct answer. Students scored significantly higher on the course exams in a college-level educational psychology class when they used clickers to answer 2 to 4 questions per lecture (clicker group), as compared to an identical class with in-class questions presented without clickers (no-clicker group, d = 0.38) or with no in-class questions (control group, d = 0.40). The clicker treatment produced a gain of approximately 1/3 of a grade point over the no-clicker and control groups, which did not differ significantly from each other. Results are consistent with the generative theory of learning, which predicts students in the clicker group are more cognitively engaged during learning.

Knapp, F.A., Desrochers, M.N. 2009. An experimental evaluation of the instructional effectiveness of a student response system: A comparison with constructed overt responding. International Journal of Teaching and Learning in Higher Education. Vol. 21, 36-46.

> Student response systems (SRSs) are increasingly being used in the classroom. However, there have been few well-controlled experimental evaluations to determine whether students benefit academically from these instructional tools. Additionally, comparisons of SRS with other interactive methods have not often been conducted. We compared SRS, Constructed Overt Response (COR), passive, and control conditions to determine their effects on learning and affect. We found that students performed better in the interactive conditions—SRS and COR—

than the other conditions. Participants' gain and retention of gain scores in the SRS condition were lower than those in the COR condition. Participants in the SRS condition perceived their condition as more enjoyable than those in the passive condition and more useful than those in the control condition. Additional research questions are raised about how these interactive methods may best improve student learning.

Mazur, E. 2009. Farewell, lecture? Science. Vol. 232, 50-51.

Discussions of education are generally predicated on the assumption that we know what education is. I hope to convince you otherwise by recounting some of my own experiences. When I started teaching introductory physics to undergraduates at Harvard University, I never asked myself how I would educate my students. I did what my teachers had done—I lectured. I thought that was how one learns. Look around anywhere in the world and you'll find lecture halls filled with students and, at the front, an instructor. This approach to education has not changed since before the Renaissance and the birth of scientific inquiry. Early in my career I received the first hints that something was wrong with teaching in this manner, but I had ignored it. Sometimes it's hard to face reality.

Ghosh, S., Renna, F. 2009.Using electronic response systems in economics classes. Journal of Economic Education. Fall. 354-367.

College instructors and students participated in a pilot project at the University of Akron to enhance student learning through the use of a common teaching pedagogy, peer instruction. The teaching pedagogy was supported by the use of technology, an electronic personal response system, which recorded student responses. The authors report their experiences in using this technology-enhanced teaching pedagogy and provide another example of an active and collaborative learning tool that instructors can use to move beyond "chalk and talk." Preliminary survey results from students participating in this pilot project are also reported.

Salemi, M.K. 2009. Clickenomics: Using a classroom response system to increase student engagement in a large-enrollment principles of economics course. Journal of Economic Education. Fall 385-406.

One of the most important challenges facing college instructors of economics is helping students engage. Engagement is particularly important in a large-enrollment Principles of Economics course, where it can help students achieve a long-lived understanding of how economists use basic economic ideas to look at the world. The author reports how instructors can use Classroom Response Systems (clickers) to promote engagement in the Principles course. He draws heavily on his own experience in teaching a one semester Principles course at the University of North Carolina at Chapel Hill but also reports on how others have used clickers to promote engagement. He concludes with evidence that students find clickers very beneficial and with an assessment of the costs and benefits of adopting a clicker system.

Beckert, T.E., Fauth, E., Olsen, K. 2009. Clicker satisfaction for students in human development: Differences for class type, prior exposure, and student talkativity. North American Journal of Psychology. Vol. 11, 599-612.

Clicker technology is growing in popularity in psychology and human development classes. It allows all students to provide instant feedback to instructor inquiry by using radio-frequency remote voting. The goal of this study was to determine the degree to which exposure, class type, and self-reported level of verbal interaction related to user satisfaction. One hundred seventy human development students participating in classrooms with clicker technology completed a 36-question clicker satisfaction survey. Overall students were satisfied with the use of clickers. Specifically students using clickers in multiple classrooms and in upperdivision classes indicated higher levels of satisfaction. Additionally, students who self-reported to be less likely to comment verbally in class indicated higher levels of satisfaction with clicker use.

Stowell, J.R. Nelson, J.M. 2007. Benefits of electronic audience response systems on student participation, learning, and emotion. Teaching of Psychology. Vol. 34, 253-250.

We compared an electronic audience response system (clickers) to standard lecture, hand-raising, and response card methods of student feedback in simulated introductory psychology classes. After hearing the same 30-min psychology lecture, participants in the clicker group had the highest classroom participation, followed by the response card group, both of which were significantly higher than the hand-raising group. Participants in the clicker group also reported greater positive emotion during the lecture and were more likely to respond honestly to in-class review questions.

Roschelle, J., Penuel, W.R., Abrahamson, L. 2004. Proceedings from the Annual Meeting of the American Educational Research Association 04: Classroom response and communication systems: Research review and theory. San Diego, CA.

In How People Learn, Bransford and colleagues (National Research Council, 1999) cite classroom response system technology and the related pedagogy as one of the most promising innovations for transforming classrooms to be more learner-, knowledge-, assessment-, and community-centered. As a step towards guiding practice and advancing research, we present our review of the research on this and more advanced, but related technologies, particularly with regard to the popular use of these systems to enhance questioning and feedback. We also formulate tentative theoretical connections to a broader scientific literature that could explain how pedagogy and technology together realize multiple desirable outcomes

Wit, E. 2003. Who wants to be…The use of a personal response system in statistics teaching. MSOR Connections. Vol. 3, 14-21.

Service courses of statistics can be among the most recalcitrant. Undergraduate students do not always see immediately the relevance of the course to their own field so that interaction with them tends to be difficult. Add on top of that the large class size, and interactive teaching may seem impossible. The development of handsets as used in Who wants to be a millionaire? has proven to be a possible tool to enhance interaction and stimulate learning. In this article we describe this personal response system (PRS) and its implementation within a statistics service course to first year psychology students.