

## DATA THAT CLICKS PRODUCES CONCEPTS THAT STICK

Janet M Winter  
Penn State University Berks College  
P.O. Box 7009  
Reading, PA 19610-6009  
[jmw11@psu.edu](mailto:jmw11@psu.edu)

### Description

Individual Response Systems or clickers can be used for formative assessment and to create an interactive learning environment. The result of the honed instruction and increased student involvement should be a measurable increase in student learning. This study compares two groups of basic statistics students taught by the same instructor in two subsequent years with on-line homework, with web posting of class information, and with power point notes. The experimental group used clickers while the control group used the same questions without clickers. Learning was compared using average test scores for the probability unit test, for the hypothesis testing unit, and for the final exam. The group tests were similar forms but not identical tests.

### Basic Technology

Before implementing clickers, some basic technology enhancements were initiated and revised over several semesters. Both groups used Mathzone for on-line homework with the same assignments. Students have access to immediate feedback for homework, immediate assistance through a “help” button, and not so immediate but daily assistance using the “ask your instructor” button. Syllabus updates, announcements or reminders, and general information were broadcast through email. All extra process directions, projects, and formula sheets were posted on ANGEL for students to download. Also, student chapter notes coordinated with the in class power point presentations were posted on ANGEL before class. The power point slides and the student chapter notes are time consuming to create even if an instructor adapts the material available with the course text book. But, the guarantee of accurate and carefully stated information, deliverable in a timely fashion, and organized for understanding is well worth the time and energy invested by an instructor. It is always possible for implementers to develop or alter textbook supplied materials in a piecewise fashion instead of revamping the entire course in one semester. Posting materials before each class session helps to encourage class preparation. Another, less time consuming approach, is to post electronic class notes from a smart board or symposium after each class, to encourage post class review.

### Individual Response Systems (Clickers)

There are various Individual Response Systems (IRS) or clicker systems available, but it is advisable to minimize complexity and student frustration by using one system for an entire college. IRS questions become a natural addition to power point presentations when they are interspersed throughout the presentation. They can also be used to review

before or after a class lecture, or they can be used to start a discussion. It is also appropriate in some situations to use only IRS questions for an entire class without any power point lecture material. Some instructors even use it to take and maintain attendance in large classes by asking at least one IRS question at the very beginning of each class and one at the very end. An IRS system that permits true/false questions, multiple choice questions, and free response numerical answers is the most flexible. But, all IRS systems engage students privately in a game like atmosphere encouraging class preparation and engagement. Each student uses an individual radio transmitter to send answers to the instructor's computer. Questions can be used to assess learning during class and provide immediate feedback from all students. After a preset or adjusted time period (15 – 30 seconds), answers are corrected and displayed in a bar graph. Based on this anonymous graphical feedback from the entire class, the instructor can modify the pace and direction of the instruction. Individual answers are recorded and accessible to the instructor, but not visible to the class. In this experiment the clicker group and the control group had the same series of questions at the same location in the lesson. Both groups were given time to work on the questions. The control group's allotted time was based on the instructor's view of "enough time to complete the problem". The experimental group's allotted time was based on the proportion of students responding to the question. If 100% of the students completed the problem before 30 seconds, the process was stopped. If less than 80% completed the problem at 30 seconds, the time was extended until at least 80% of the students responded. The clicker group always viewed the graphical display of the class's answers. Both groups viewed the correct solution to every problem. The clicker group received less time viewing the correct solution when problems were completed correctly by 80% - 100% of the class. The clicker group received additional instruction and extra time viewing correct solutions when they were not completed correctly by at least 80% of the students.

#### Faculty and Student Surveys

Both faculty and student groups completed an opinion survey about IRS questions. Seven faculty members using clickers in biology, chemistry, kinesiology, instructional technology, and statistics classes responded with an average of 3.14 class sections of clicker use. Their use ranged from the entire class to several times in specific units of a course. All stated that they would continue to use clickers in subsequent semesters. The replies to "How have clickers changed the way you teach?" included these comments:

"Spend more time doing problems in class in preparation for homework and less time going over homework afterwards in class"

"Not really – they allow me to assess student learning from one class to the next"

"They make it easy to gauge student knowledge and also allow me to ask questions student might not feel comfortable answering in front of their peers"

"Instant feedback has made me more responsive to student misconceptions and has helped me redesign the next offering of a course."

The faculty's issues with the IRS system included concerns about the optimum time for students to send in answers and optimum ways to modify a lesson based on the IRS answer distribution. At this time, the IRS system that we are using does not permit quick creation of new questions, and so reassessment with IRS is not possible unless it is preplanned.

In addition to the faculty survey, one hundred and eight introductory statistics students completed a similar survey and responded with comments:

"I sometimes need more time to complete the questions"

"I am worried about getting wrong answers"

"I am happy when I get the questions right"

### **AVERAGE SURVEY RESULTS**

Rate the influence of clicker use in each area using a scale 0 (none) to 10 (best)

<b><u>Area</u></b>	<b><u>Student</u></b>	<b><u>Faculty</u></b>	<b><u>p-value</u></b>
1. Effectiveness on your learning	5.94		
2. Understanding of concepts	5.66	5.57	.4680
3. Practicing concepts	7.27	8.14	.1055
4. Measuring your learning	6.31	8.71	.0001**
5. Keeping you involved	7.75	8.14	.2498
6. Encouraging class Preparation	6.16	4.43	.0540*

*Note: Faculty (n = 7); Students (n = 108)*

The faculty's average rating for the using of clickers to "measure learning" is statistically significantly higher than the student's average rating. Students, on the other hand, were statistically significantly higher in average rating for "encouraging class preparation." Evidentially, recording clicker answers in a grade book did influence students more than the faculty thought it would.

### **Experimental Results**

This study compares two groups of basic statistics students taught by the same instructor in two sequential years with on-line homework, with web posting of class information, and with power point notes. The only difference between the two groups was the use of the IRS system in the experimental group for the probability unit (unit 2) and all subsequent units of the course. Both groups solved the same problems, but the experimental group transmitted their answers to the podium computer, viewed the graphical display of all answers, and knew how well they understood a concept compared to their classmates before the solution to each problem was displayed and explained. Learning was measured using average test scores for the two groups for the probability

unit test (unit 2), for the hypothesis testing unit, and for the final exam. Tests were comparable forms but not identical tests. Before implementing clickers, both groups used exactly the same materials for the first descriptive statistics unit. The average test score for unit 1 for the non-clicker or control group ( $\bar{X}_{cont} = 72.44$   $n = 130$ ) was statistically significantly higher ( $p = 0.006$ ) than the experimental group ( $\bar{X}_{exp} = 67.91$   $n = 121$ ). Average test grades declined 7 points between unit 1 and unit 2 for the control group, but the average test score for the probability unit (unit 2) was actually higher for the experimental group ( $\bar{X}_{exp} = 69.8$   $n = 121$ ) than for unit 1. There was a statistically significant difference ( $p = .023$ ) between the expected drop of 7 points in average score and an increase of 1.89 points in average score. When comparing the grades for both groups for unit 2, the experimental groups was also higher than the control group ( $\bar{X}_{control} = 67.5$   $n = 119$ ), although it was not statistically significantly higher ( $p = .188$ ). Thus, the usual drop in average test score between unit 1 and unit 2 did not occur for the clicker group. Also, the clicker group, which had been statistically significantly lower in basic skills in unit 1, was now at approximately the same level as the control group. Although the improvement did not continue, the two groups did remain at about the same average for the hypothesis testing unit ( $\bar{X}_{exp} = 75.2$ ,  $\bar{X}_{control} = 76.0$ ) and the final exam. In fact, the actual standardized difference in average scores for the final exam between the two groups was 0.19 with a p-value = .4249.

### Conclusions

Although the opinion polls of both faculty and student groups definitely support the use of clickers as a worthwhile way to engage students, to evaluate learning, and to be responsive to students' needs, there was no statistically significant gain in average final exam score for the clicker group compared to the control group. However, the experimental clicker group, whose group average was statistically significantly lower in basic concepts, did complete the introductory statistics course with approximately the same final exam average score as the control group and did have a gain in comprehension in the probability unit. The conclusion of this study is not a simple "yes" or "no" to the use of clickers, but a beginning of an answer to when and where clickers are most effective. In the introductory statistics course, using the same questions with clickers improved student comprehension in the probability unit, but did not improve comprehension in the hypothesis testing unit.