



A Study of How the Use of a Personal Response System Affects Student Learning in a General Chemistry Course

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Introduction

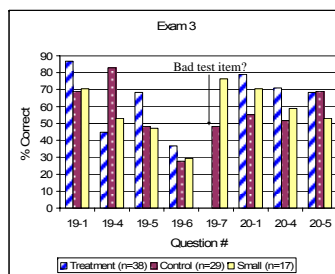
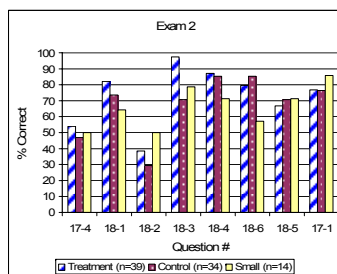
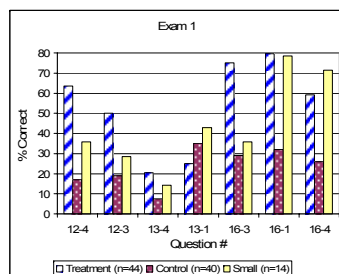
Personal response systems, or clickers, are currently getting a lot of attention. Many instructors are collecting data about student attitudes towards the systems, but little is known about the effect, if any, of their use on learning outcomes. One position is that students who are more engaged in class will learn more. An opposing position is that, even if the technology is engaging, it has either no effect or a detrimental effect on student learning. We hypothesized that the formative feedback provided by the response system might aid student metacognition and lead to more productive study and, ultimately, better test performance.

Study Design

Student behavior and performance were studied in two classes with similar initial enrollments (48 and 49 students). The two sections had different instructors, but the instructors met weekly to decide on pre- and post-lecture questions that would be asked in both classes. Students answered the questions with the personal response system in one class (treatment class) and orally in the other (control class).

The instructors also jointly determined which questions would be duplicated, with slight modifications, on the three exams. Each instructor prepared his or her own exam making sure to include the agreed upon items. Summary data for each test was collected with Scantron item analysis forms. Test performance by a third class with an initial enrollment of 15 students (small class), taught by the same instructor and in the same fashion as the control class, was also monitored to provide an idea of class size effect.

Test Results



Exam 1	
$H_0: \mu_{\text{treatment}} - \mu_{\text{control}} = 0$	$H_0: \mu_{\text{treatment}} - \mu_{\text{small}} = 0$
$H_a: \mu_{\text{treatment}} - \mu_{\text{control}} > 0$	$H_a: \mu_{\text{treatment}} - \mu_{\text{small}} > 0$
t 3.665	t 1.173
$t_{.050}$ 1.943 accept H_0	$t_{.050}$ 1.943 accept H_0
$t_{.100}$ 1.440 accept H_0	$t_{.100}$ 1.440 accept H_0

Exam 2	
$H_0: \mu_{\text{treatment}} - \mu_{\text{control}} = 0$	$H_0: \mu_{\text{treatment}} - \mu_{\text{small}} = 0$
$H_a: \mu_{\text{treatment}} - \mu_{\text{control}} > 0$	$H_a: \mu_{\text{treatment}} - \mu_{\text{small}} > 0$
t 1.598	t 1.383
$t_{.050}$ 1.895 accept H_0	$t_{.050}$ 1.895 accept H_0
$t_{.100}$ 1.415 accept H_0	$t_{.100}$ 1.415 accept H_0

Exam 3	
$H_0: \mu_{\text{treatment}} - \mu_{\text{control}} = 0$	$H_0: \mu_{\text{treatment}} - \mu_{\text{small}} = 0$
$H_a: \mu_{\text{treatment}} - \mu_{\text{control}} > 0$	$H_a: \mu_{\text{treatment}} - \mu_{\text{small}} > 0$
t 0.045	t -0.039
$t_{.050}$ 1.895 accept H_0	$t_{.050}$ 1.943 accept H_0
$t_{.100}$ 1.415 accept H_0	$t_{.100}$ 1.440 accept H_0

*Omitting question 19-7

The treatment class scored better than the control class on 5 of 8 questions. There was no significant difference between the treatment and control class performance even at the 90% confidence level.

The treatment class scored better than the small class on 6 of 8 questions. The treatment class performed significantly better than the small class at the 95% confidence level with question 19-7 omitted.

The treatment class scored better than the control class on 6 of 7 questions. The treatment class performed significantly better than the control class at the 95% confidence level.

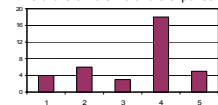
The treatment class scored better than the small class on 5 of 7 questions. There was no significant difference between the treatment and small class performance even at the 90% confidence level.

The treatment class scored better than the control class on 6 of 8 questions. The treatment class performed significantly better than the control class at the 90% confidence level.

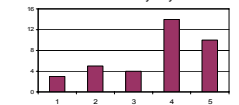
The treatment class scored better than the small class on 6 of 8 questions. There was no significant difference between the treatment and small class performance even at the 90% confidence level.

Survey Results

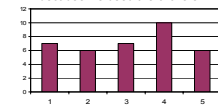
The clickers were worth the expense.



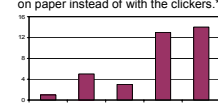
It was worth the effort to bring the clicker to class every day.



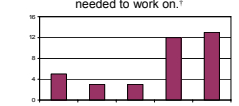
I was more motivated to attend class than I would have been otherwise because we used the clickers.



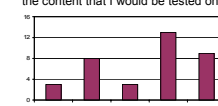
I would have been equally motivated to attend class if attendance were recorded on paper instead of with the clickers.*



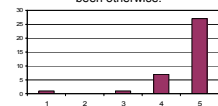
My performance on the clicker questions helped me identify weak spots that I needed to work on.†



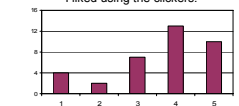
Using the clickers helped me focus on the content that I would be tested on.†



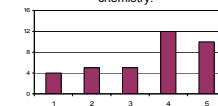
I was more likely to answer a question in class using the clicker than I would have been otherwise.



I liked using the clickers.



I think the chemistry department should continue to use the clickers in general chemistry.



1 = strongly disagree 2 = somewhat disagree 3 = neither agree nor disagree 4 = somewhat agree 5 = strongly agree

Pre-/Post-lecture Results

The treatment class performed even better on 15 of 23 questions (65%) when they were asked on exams than they had on similar questions asked post-lecture. However, a paired difference experiment showed that the gain in scores was statistically different (90% confidence level) for the second exam only. This appears to support student survey responses claiming that the majority of them (60-70%) did reflect on their clicker question performance (see questions marked † above) when studying.

Attendance and Retention

Class	Treatment	Control	Small
Average attendance of students not dropped	89%	91%	93%
Students taking 1st exam	44	40	15
Students taking 3rd exam	38	31	15
# of students lost	6	9	0
Retention from 1st to 3rd	86.4%	77.5%	100%

There was essentially no difference in attendance between the treatment and control classes. This is consistent with the student survey result that 75% of students said they would be equally likely to attend class if the attendance were taken by hand (see question marked † above). The retention rate was roughly 10% higher in the treatment class than in the control class.

Conclusions

The treatment class outscored the control class on 17/23 test items. A paired difference experiment showed that the difference was statistically significant for the first two exams. The treatment class outscored the small class on 16/23 test items, but the difference was significant only on exam 3. The unexpected results on exam 3 may be due, in part, to two factors: (1) scores were reported for only 31 students in the control class compared to 38 in the treatment class, and (2) the scores of two students from the control class who took make-up exams with the small class were included in the small class results for exam 3. Some portion of the overall difference in performance may also be due to a different instructor for the treatment class.

Statistical analysis also showed that students in the treatment class retained the learning gains made from pre- to post-lecture on the exams and even improved significantly on one exam. The treatment class had a higher retention rate than the control class while both had very high attendance. Survey responses from the treatment class are consistent with the data. They responded positively overall to survey questions about the use of the response system in the class.

Acknowledgement

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