

# Can a \$30 Piece of Plastic Improve Learning?

## An Evaluation of Personal Responses Systems in Large Classroom Settings

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### **ABSTRACT**

Encouraging active learning with students, especially in large classrooms, can be a challenge for faculty. The present study examines the effectiveness of personal response systems (PRS), a technological intervention for facilitating active learning in large enrollment classrooms. The PRS records, tabulates and reports in real-time multiple choice responses from students using handheld devices. 512 students completed a questionnaire addressing perceived usefulness and pedagogical value of the device at the beginning and end of the semester. The results indicate high levels of satisfaction with the technology overall. The data also reveal an increase in the perceived pedagogical value of the devices over the course of the semester.

### **Author Keywords**

Personal response system (PRS), polling, large classroom, peer to peer instruction, instructional technology

### **ACM Classification Keywords**

E-Learning and Education, Empirical Methods, Quantitative, Input and Interaction Technologies

### **INTRODUCTION**

A faculty member looks out at the students in the lecture hall – all 400 of them. Some eager students have arrived early and sit in the front row. But many have shuffled in at the last moment and simply found the first open seat. Still others arrived after the professor starts the lecture and sit in the last few rows. Some of the students hang on every word but many are distracted with other things; newspapers, laptops and backpacks. The faculty member knits his brow and continues on with his lecture.

This is a common situation faced by many faculty. Large lectures halls for introductory courses are the norm at most universities and colleges in this country. In fact most institutions could easily quantify this phenomenon through simple metrics. In one example, almost 50% of the student enrollment is represented in 25 courses. Twigg 1995 [8]

Yet, despite their proliferation, large lecture classes present several pedagogical challenges. Cordes [2] identified a number of issues cited from faculty as problems with large

classes, such as difficulty gauging student progress, diminished opportunities for active and cooperative learning, and lack of opportunities for student participation. These issues describe an environment that severely limits opportunities to adhere to practices for effective instruction. For example, Chickering and Gamson [1] identify principles such as encouraging contact between students and faculty, giving prompt feedback, and promoting active learning as critical for effective undergraduate education.

Sound educational practice calls for active participation from students, yet large classes do not seem to encourage this type of engagement. In classes with more than 40 students, Karp and Yoels [3] found that only 2 -3 students accounted for 50% of the student comments. Another study found that 60% of the students stated that a large number of classmates listening would deter them from answering questions in class, even when encouraged to do so by the instructor. [9] Stones 1970.

Given these challenges, university faculty have begun to look to technology to overcome obstacles to active class participation. One attempt to ameliorate the logistical difficulties of fostering participation in large lecture classroom settings is the Personal Response Systems (PRS), an in-class polling system. The PRS records, tabulates and reports in real-time, single or multiple choice responses from students using handheld devices. This allows the professor to incorporate questioning, discussion and immediate feedback of results into course design, important educational techniques according to numerous studies [5] [6].

There appears to be strong interest by university faculty in this kind of system. In one study examining faculty's use of technology and their attitudes about a variety of instructional technologies, approximately one quarter of the faculty reported that they would like an in-class polling system for their class. [10]

The objective of the present study was to evaluate the use of a PRS in a large classroom setting. Consistent with Learner Centered Design (LCD; Quintanna, Krajcik, Soloway & Norris[7], which advocates an approach in

which the designing and evaluating technology must be grounded in the learner's experience, the focus of the study was on the learner's view of the PRS. In particular, we were interested in:

1. To what degree students were satisfied with the PRS, and whether students believed that the PRS enhanced their learning in the course.
2. To what degree was the use of the PRS perceived to motivate attendance and participation in the class.
3. To what degree did the PRS play a role in facilitating discussion and a sense of community with fellow students in the class.
4. How would these views of the PRS change over time?

### SYSTEM DESCRIPTION

There are many variations of personal response systems. This study focused on one from H-ITT (Hyper-Interactive Teaching Technology) that was implemented for the first time in a large introductory biology course in the fall 2004 semester. This system allows faculty to efficiently pose multiple choice questions to the class. The system records individual responses from students through handheld devices (see Figure 1) and provides immediate feedback that responses have been registered without revealing an individual's response (Figure 2). In this fashion, students' responses are anonymous to each other yet verified as having been recorded. The system can then tabulate results and display the correct answer along with information on class performance (See Figure 3).

### SURVEY METHOD

In the fall of 2004, approximately 700 Cornell students enrolled in courses in Biology 101 were asked to complete two surveys regarding their experience with a new technology-based intervention introduced in this large class. The first survey consisted of twenty-eight multiple-choice questions that utilize a Likert-type scale and three open ended questions to assess the effectiveness of the PRS technology. The first web-based survey was conducted from October 6-11 with an 85% return rate. The second web-based survey consisted of eleven multiple-choice questions that utilize a Likert-type scale and one open ended question and was conducted from November 18-24 with a 77% return rate.



Figure 1 – Personal response system from H-ITT.

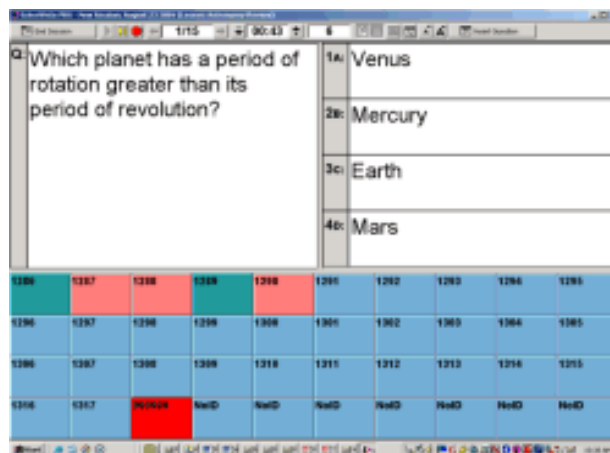


Figure 2. A screen display of question with response identified.

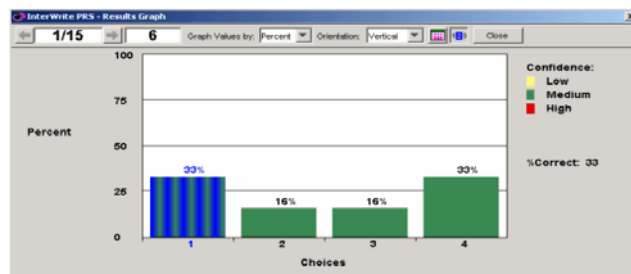


Figure 3. Print Screen of Results Graph display

Demographic data was collected on variables such as student gender, academic level, previous biology course experience, previous biology course performance, motivation for taking this course, other experience in using a personal response system, and which time the student attended the lecture. This background data was analyzed against items that assess student attitudes about topics including attendance of lectures, perceived increase in student engagement in lecture, perceived enhanced learning, student satisfaction, and perceived sense of community with classmates, and comparison with other instructional technologies used in this course.

### RESULTS

The majority of students (80%) responding to the survey were college freshman. Women made up 60% of the respondents. Most had either high school (48%) or AP (45%) biology course experience and most were A students (78%). Motivation to take this course was based on 38% being biology majors and 46% were pre-med.

Two types of statistical tests were applied to the data. The first were one-sample t-tests that compared the average student response to the mid-point of the Likert scale questions (i.e., 3). The second were paired-sample t-tests that compared student responses at Time 1 and Time 2.

Our first question of interest was whether students had a positive experience with the PRS. The data suggest that initial satisfaction levels with the PRS at the beginning of the semester was above the mid-point ( $M = 3.33$ ,  $SD = 1.04$ ),  $t(588) = 7.75$ ,  $p < .001$ . In addition, satisfaction with

the system significantly increased over the course of the semester ( $M = 3.45$ ,  $SD = 1.02$ ),  $t(511) = -1.94$ ,  $p = .05$ , suggesting that experience with the device improved learner satisfaction with the device.

The second general question of interest was how students perceived the device within the class context (see Table 1). First, the data suggest that the PRS played some role in

<i>(Strongly Disagree=1, Strongly Agree=5)</i>	Time 1 Mean (Std.Dev)	Time 2 Mean (Std.Dev)
1. I am more likely to attend lectures for this course because of the PRS	3.27 (1.24)	3.69 (1.10)
2. I believe that I was more actively engaged in the class lectures because of the PRS	3.68 (1.04)	3.68 (1.05)
3. Finding out the correct answer promptly is important to me	4.34 (0.82)	4.25 (0.88)
4. Understanding how my classmates answered questions is important to me	3.61 (0.97)	3.49 (0.99)
5. I believe that the corresponding discussion with my adjacent classmates was valuable	3.30 (1.07)	3.11 (1.02)
6. I believe that the use of polling systems in this course has enhanced a sense of community with fellow classmates	2.85 (0.99)	2.85 (1.01)
7. I believe that the use of polling systems in this course has enhanced my learning in this course	3.32 (1.09)	3.30 (1.09)

**Table 1.**

drawing students to class (see Question 1). Students reported that they were more likely to attend class because of the PRS,  $t(589) = 5.51$ ,  $p < .001$ . Perhaps more importantly, as the course progressed, the degree to which students came to class because of the PRS increased,  $t(512) = -7.85$ ,  $p < .001$ .

Once actually in the classroom, students reported that the PRS lead them to be more actively engaged in the class lectures (see Question 2),  $t(587) = 15.45$ ,  $p < .001$ , and this perception remained constant over the semester,  $t(509) = .04$ , *ns*. The data suggest that of particular importance to students in this respect was the ability to find out the correct answer promptly (see Question 3). Student responses to this

question was significantly greater than the midpoint,  $t(586) = 38.57$ ,  $p < .001$ , although this favorable response decreased across Time 1 and 2,  $t(508) = 2.43$ ,  $p < .05$ .

With regard to how the PRS affected their interactions with their classmates, students reported that knowing how classmates answered a question was valued (see Question 4),  $t(588) = 14.56$ ,  $p < .001$ , and that this did not change over the semester, although the perceived value decreased over the semester,  $t(508) = 2.58$ ,  $p < .01$ . The students also found the corresponding discussion with classmates valuable (see Question 5),  $t(588) = 6.34$ ,  $p < .001$ . However, the PRS device did not foster a sense of community among classmates (see Question 6). Indeed, this item was the only one to average significantly below the mid-point,  $t(588) = -3.84$ ,  $p < .001$ . Considered together, these data suggest that students do value promptly knowing their classmates answers to questions and the ensuing discussion. There was considerably less appreciation for the PRS device as a tool to enhance community with their classmates.

Finally, Question 7 examined whether students believed that the PRS has any ultimate effect in enhancing the student's learning in the course (see Question 7). The data suggest that students did in fact believe that the PRS ultimately enhanced their learning in the course,  $t(588) = 6.70$ ,  $p < .001$ , and this perception remained constant across the semester,  $t(509) = .46$ , *ns*.

The study examined a number of student attributes like gender, academic level, previous biology experience and grade, and motivation for taking the course. Correlation analysis did not yield any significant relationship with the use of the device, satisfaction with the PRS, or other resulting experiences of the PRS such as perception of enhanced learning or more active engagement in the lecture, suggesting that the device was perceived similarly across student demographics.

Finally, a set of analyses was conducted to determine how frequency of use related to satisfaction and perceived value of the device. The use of the device was positively correlated with satisfaction at both Time 1 ( $r = .27$ ,  $p < .01$ ) and Time 2 ( $r = .23$ ,  $p < .01$ ), a common sense finding suggesting that the more students used the PRS, the more they like it. Use of the device also correlated with more active engagement in the lecture ( $r = .20$ ,  $p < .01$ ) and enhanced learning ( $r = .14$ ,  $p < .01$ ). Given the importance of increasing active engagement in learning (2), this is a promising finding suggesting that students perceive this potential for the PRS.

## DISCUSSION

This study provides encouragement to faculty and staff that are interested in supporting the use of PRS to address key issues in large enrollment classrooms. The data suggest generally positive answers to the specific research questions posed by this study.

First, students were satisfied with the PRS, and their satisfaction improved over time. Students also responded that they believed that the PRS enhanced their learning in the course.

**“I really liked the PRS at the beginning of the year because I thought it was just cool to answer questions with a laser. Now, I really like it because we go over the questions in depth so I can understand the topic.”** *(Student comment)*

Students reported that they were more likely to attend the lectures due to the PRS. Perhaps of greater importance, students felt that they were more actively engaged in the lectures.

**“I prefer it more now and understand its’ significance in the course. Without its’ implementation, I would probably skip lecture or fall asleep. It makes me actively learn biology.”** *(Student comment)*

With regard to interaction with classmates and creating a sense of community, the results are mixed. Students did report a positive experience with the interaction with their fellow classmates. However, there was a lack of appreciation for the creating a sense of community.

**“I think there was more discussion when we were asked to put in our own answer and then defend it against the opinions of those around us. After being in this class for a few months, I am more likely to engage my neighbors in a discussion about the questions and information.”** *(Student comment)*

In general, students positively received the PRS system, and in a number of areas their evaluations improved over time.

**“It seems that everyone, both professor and students, are becoming more and more used to the system and the way it should proceed. As the semester went on, the PRS became a more understood and valuable tool in conceptual learning.”** *(Student comment)*

#### FUTURE CONSIDERATIONS

To balance the cautious optimism associated with this study, the researchers encourage additional investigation. Future explorations regarding this intervention should include the following:

- Continue to track these students in future biology courses
- More extensive analysis of the faculty perspective
- While this study focused on the experience, a review of the PRS design would be valuable
- Compare PRS implementations across multiple disciplines

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