Relating Student Engagement and Immediate Feedback to Academic Performance

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Abstract

This action research project investigated the use of Classroom Performance System (CPS) student response pads to provide both the teacher and students with immediate feedback regarding student understanding. Use of the remote response pads was integrated into lesson plans, allowing students to review material for tests and providing the teacher the opportunity to address misconceptions immediately. Data regarding student participation and students’ answer choices were recorded via the CPS software and were available immediately after the time period to answer a question elapsed. Findings indicate that student participation reached 90% with the use of CPS clickers, an increase over levels of student participation reported by other teachers using alternative active learning methods in the classroom. Data also indicate that students performed better on assessments than their peers whose classes did not integrate the response pads into the classroom.

Background/Context

Education today encourages teachers to evaluate their teaching methods in an effort to engage an ever-changing student population. One process that affords teachers this opportunity is action research. Action research is a reflective process that allows the educator to evaluate the effectiveness of his or her teaching through reflection and systematic data collection and analysis.

Technology is making it possible to increase the amount of active learning in the classroom and fully engage learners. We now have the ability to provide immediate results to students, providing real-time assessment through the use of a Classroom Performance System (CPS). A CPS provides each individual student with a response pad, involving every student in the classroom. Questions can be asked to the class through various means, including verbally, on paper, or through Microsoft PowerPoint presentations. Students enter their responses using the response pads, and the responses are transmitted to an infrared receiver. Teachers can
immediately access results and assess the needs of the class. Although the response from each student is tracked for the instructor, the students’ responses are anonymous to each other when using a response pad, thereby eliminating the fear of embarrassment when answering incorrectly. Use of the CPS simultaneously encourages student participation and provides real-time assessment data.

With immediate feedback regarding student comprehension, the CPS allows the teacher to provide differentiated learning to students by confronting known misconceptions. Real-time assessment of the students’ understanding of the lesson material allows the teacher to modify lesson plans based on the student’s level of comprehension before proceeding. It makes the class more interactive by encouraging classroom discussion. And in science classes, it can also be used for predicting results of in-class laboratory activities.

In order to see if this technology is effective at increasing student participation and student assessment performance with my students, I received training on the use of the CPS and integrated it into the classroom. Besides evaluating the level of student participation with the use of CPS clickers, student attitude towards clicker use in class was assessed by obtaining quantitative data from the students regarding their perception of the use of the clickers as an effective learning tool. Additionally, I investigated whether using the CPS to provide students with immediate feedback is helping them to learn more effectively by analyzing assessment scores. I have 125 9th and 10th grade Biology students that utilized the CPS system in class. To evaluate quantitative data to determine the effect of CPS use on student learning, my assessment data is compared with that of other Biology teachers who are utilizing the same curriculum and assessments, but not a CPS, to see if there is a difference in assessment proficiency. The control
group consisted of 471 9th and 10th grade Biology students instructed by four other biology teachers.

**Literature Review**

Teachers are continually looking for innovative methods to improve student learning. Integrating the use of new technologies into the classroom is one option becoming increasingly available, if financial burdens and teacher learning curves can be overcome. Classroom response systems are one type of technology that is designed to actively engage students in classroom. Whereas traditionally teachers may have used strategies such as individual student white boards or flash cards to engage students in learning and to assess their comprehension, the CPS offers several advantages. Students are able to submit their answer choices in a method anonymous to his or her peers, while the teacher is able to immediately analyze classroom results and provide students with instant feedback. One might infer that elevated participation and engagement means increased student learning, but O’Donoghue and O’Steen (2007) sought to systematically determine if this was the case by interviewing staff using or planning to use a classroom response system and surveying students regarding their experience of using clickers. In this study, staff reported initial technological issues integrating the system into the classroom, particularly during limited preparation time. However, with time both staff and students became comfortable with regular integration into the classroom. Surveying student perception through a series of multiple choice questions indicated that students felt that use of the clickers aided student exploration of their understanding of concepts and that a majority of student would choose to take a course in which they are used occasionally. The authors were careful to note that specific integration of the clickers into lesson plans must be determined by the instructor to adapt to each individual class context.
Although the previous study evaluated student learning by surveying student perception of learning, Martyn (2007) compared the use of a classroom response system to classroom discussion, both types of active learning, to distinguish if increased student learning was attributable to the pedagogy of active learning or if it was a result of CPS integration. These two methods of active learning are distinguished from one another, as the classroom response system is anonymous, uses a competitive format, and gives every student an opportunity to answer every question. Student scores on a comprehensive final exam were compared and adjusted for differences in pretest score. Ultimately, Martyn (2007) did not find any statistically significant difference in performance on the final exam scores. However, students who used the CPS, on average, perceived more value on the CPS use in the classroom than students involved with group discussion felt about the benefits of the discussion. The author does suggest that perhaps active learning, independent of the means used in the classroom, engages students and aids student learning. However, she also acknowledges that perhaps after the instructor has become more familiar with integration of this technology, the results of a similar study may show significant differences with utilization of the CPS in the classroom.

Thalheimer (2007) developed guidelines for integration of questioning strategies to maximize student learning and engagement with CPS use. He points out that the success of CPS technology rests not on the technology itself but rather how it is integrated into instruction. A common implementation of the CPS system is to enhance lecture effectiveness. Thalheimer points out that lectures, although valuable, are dominated by passive learning, where instructors and learners had difficulty assessing learning progress. Thalheimer delineates steps to be successful with CPS implementation including defining instructional goals, writing high-quality questions, engaging in meaningful discussion regarding each question, and utilizing feedback to
modify instruction. And, similar to Martyn (2007), Thalheimer notes that although other types of well-designed and well-implemented active learning strategies may yield positive results benefitting student learning, CPS offers unique advantages including anonymity, detailed data analysis, and a “cool factor”.

Although I recognized that integration of the CPS system into the classroom required both teacher and student training, I felt that the technology was an innovative way to increase my student participation and student learning. This technology offers a new option to help reach students who are growing up in an increasingly technological environment. Based on the review of literature regarding CPS use in the classroom, I devised two groups of students who were exposed to active learning in the classroom, one group was limited to classroom discussion and verbal questioning, whereas the other group had CPS integration into instruction. Questions asked via the CPS were constructed ahead of time and directly related to the learning objectives in the course.

**Methodology**

**Participants**

The students participating in this study were 596 9th and 10th graders enrolled in Biology at a suburban high school in Sugar Land, Texas, USA. Of these, 125 students utilized the CPS in class (experimental group), and the remaining 471 experienced classroom discussion as the active learning strategy in the classes (control group). All teachers participated in a common planning period and shared teaching resources including student notes, Microsoft PowerPoint presentations, classroom and laboratory activities, and assessments.

**Materials**
The CPS system (including receiver, student response pads, and software) was obtained from eInstruction Corporation (Denton, TX, USA). The teacher received 3 hours of training on the use of the system from an eInstruction consultant. Students received hands-on training on the use of the CPS response pads by the teacher for approximately 15 minutes and reviewed the procedure before each use. Each student was assigned a specific response pad to record individual student data using the CPS software. Multiple-choice questions were prepared ahead of time and utilized in conjunction with the CPS software. Students were given 40 seconds per question to submit and change their answer.

Data Sources

To obtain student participation data for the experimental group of students, information collected by the CPS software during utilization of the CPS was accessed. To obtain student participation levels for the control group, teachers were asked to self-report student participation. Student perceptions and attitudes of CPS integration were collected using the CPS system itself. Assessment scores were obtained from District Assessment Results.

Data Collection and Analysis

Student participation data during the 3rd nine weeks grading period for the experimental group was calculated from data extracted from the CPS software. Student participation was determined by dividing the number of responses a student submitted by the total number of questions presented during the nine week grading period; all student participation rates were averaged. For students in the control group, the teachers self-reported the percentage of students who participated during active learning in the classroom, including interactive classroom discussion and verbal questioning during lecture. To self-report student participation teachers
were asked to calculate the percentage of students who would offer an answer if they were called up during class. Error was determined by calculating the standard deviation.

All Biology students in the study were provided with the same assessments. All students took a pretest prior to implementation of the CPS system into the experimental group of students, and nine weeks later took a district assessment. Quantitative data regarding student performance was obtained from experimental and controls groups both before and after integration of the CPS system into the classrooms (Table 1). The mean and standard deviation of student pretest scores and district assessment scores were calculated for both groups of students. The data sets from both groups were analyzed using a two-tailed Student’s t-test to establish if the groups of students had statistically significant scores ($p < 0.01$). All statistical calculations were performed using Microsoft Excel (Microsoft Corporation, Redmond, WA, USA).

Quantitative data regarding student perception of their learning using the CPS was determined using a student survey (Table 2). Student responses were averaged to determine the overall student perception of the effectiveness of CPS. Statements were rated as Strongly Agree (5), Agree (4), Unsure (3), Disagree (2), and Strongly Disagree (1).

**Findings**

**Student Participation**

Student participation during active learning in the control group was determined by teacher self-report, and ranged from 30% to 70%, with the mean at 52.6% (17.1%). Students using the CPS have a participation level of 90.0% (5.1%). Students utilizing the CPS system had a significantly greater participation rate as compared with students using the traditional active learning method of including student questioning to check for understanding at various points during lecture.
**Student learning as measured by student performance**

All Biology students in the study were provided with the same assessments. All students took a pretest prior to implementation of the CPS system into the experimental group of students. As shown in Table 1, the control group had a pretest mean of 49.8% (17.3%) and the experimental group had a pretest mean of 52.1% (18.7). Comparison of these two data sets using Student’s t-test indicates they are not statistically different at $p = 0.219$.

Analysis of a district assessment to evaluate student knowledge from the 3rd nine weeks grading period indicated that the students in the experimental group that had integrated CPS usage into the classroom had a mean of 71.2% (8.6), whereas students in the control group of students had a mean of 65.9% (17.0). Comparison of these two data sets using Student’s t-test indicates they are statistically different at $p < 0.003$ (see Table 1).

Table 1

**Student Assessment Scores**

<table>
<thead>
<tr>
<th></th>
<th>Experimental Group (mean ± standard deviation)</th>
<th>Control Group (mean ± standard deviation)</th>
<th>t-test (* = statistically significant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Pretest Score</td>
<td>52.1 (18.7)</td>
<td>49.8 (17.3)</td>
<td>$p = 0.219$</td>
</tr>
<tr>
<td>(percentage)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean District Assessment Score (percentage)</td>
<td>71.2 (18.6)</td>
<td>65.6 (17.0)</td>
<td>$p &lt; 0.003*$</td>
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**Student perception of learning**

Students in the experimental group were given a survey consisting of nine statements referring to their perception of the CPS system, including how it influenced their participation in class, their learning, and if they enjoyed using them in class (Table 2). Overall all nine statements had favorable responses, indicating that the students liked using the CPS in class (mean = 4.04) and would like to use it in other classes (mean = 4.30). The student population
indicated they would liked to have used the remote clickers more often in class (mean = 4.00), and believe the clickers helped their learning (mean = 3.70) and, to a lesser extent, their performance (mean = 3.34), in class.

Table 2

Results of Student Survey

<table>
<thead>
<tr>
<th>Survey Statement</th>
<th>Mean*</th>
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<tbody>
<tr>
<td>I liked using the remote clickers in class</td>
<td>4.04</td>
</tr>
<tr>
<td>Using the remote clickers increased my participation in class</td>
<td>3.93</td>
</tr>
<tr>
<td>I feel that using the remote clickers helped me learn</td>
<td>3.70</td>
</tr>
<tr>
<td>I liked knowing immediately if I had answered the questions correctly</td>
<td>4.16</td>
</tr>
<tr>
<td>I liked knowing that my answer choice was kept hidden from other students.</td>
<td>3.53</td>
</tr>
<tr>
<td>Using the remote clickers helped improve my performance in class</td>
<td>3.34</td>
</tr>
<tr>
<td>I would like to have used the remote clickers in class more often</td>
<td>4.00</td>
</tr>
<tr>
<td>I would like to use remote clickers in other classes</td>
<td>4.30</td>
</tr>
<tr>
<td>I would recommend that my teacher use remote clickers in other classes.</td>
<td>3.90</td>
</tr>
</tbody>
</table>

* 5 = Strongly Agree, 4 = Agree, 3 = Unsure, 2 = Disagree, 1 = Strongly Disagree

Discussion/Conclusion

The results of this study demonstrate student participation in class increased with CPS integration. In terms of their pre-assessment scores, the student populations were not statistically different. Because all teachers used the same teaching resources with the exception of CPS integration, comparison of post-test results are indicative of the influence of the CPS itself. Statistical analyses of post-test (district assessment) results demonstrate that the students using the CPS performed significantly better than their counterparts in the control group ($p < 0.003$).

Student participation was evaluated by looking at the percentage of questions answered by students when the CPS was used in class. Rates of student participation in this group of students had a mean of 90%, whereas in the control group the mean of student participation was 52.6%. Not only did the data indicate students had higher participation rates with CPS use, but
the Student Survey results in Table 2, indicated that the students agreed with the statement “Using the remote clickers increased my participation in class”.

Student learning was assessed by first comparing the student populations using a pretest. Comparison of the means of both student populations using Student’s t-test indicated that there was no difference in student knowledge prior to integration of the CPS. After integration of the CPS, all students were given a district assessment. The mean score of each student population was calculated and compared using Student’s t-test. The analysis of these data demonstrated the experimental group performed statistically better than the control group of students ($p < 0.003$).

Students completed a survey evaluating nine statements and rating them by the degree they agreed with statements. Overall, students liked using the remotes in class, would have preferred to use them more often in this and other classes, and appreciated knowing immediately if they had answered correctly (mean ≥ 4.00). However, student perception of whether their participation in class increased, and if the CPS helped them learn and improved their performance was rated slightly lower (range of the means: 3.34 to 3.93). The anonymity of the process was rated at a mean of 3.53, suggesting that students perceived the anonymity of the process to be less important than the process itself.

This research was a simple study to evaluate the impact of CPS integration into the classroom. Although the two groups of students were exposed to different faculty, the experimental group and the control group of students were instructed using the same curricular materials and assessments minimizing the effect of individual teaching differences. These preliminary data indicate an increase in both participation and performance after integration, as well as an overall positive reception of CPS use by the students. Although this technology is expensive and has a learning curve for both students and teachers, this study suggests the
allocation of resources to expand this technology would be resources that are well dispersed. Long-term studies comparing students who take courses consistently integrating CPS with those who do not would provide more substantial data regarding the impact of this technology on student learning and performance.

References


Appendix A  Use of the CPS

Each student receives his or her own remote used to answer questions asked by the instructor, and the student answers are recorded using the receiver and computer software. (Thalheimer, 2007, March)