An evaluation of the effectiveness of the instructional methods used with a Student Response System at a large university

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Summary

This study investigates the adoption of student response systems (SRS) across a large university campus. The study sought to understand how faculty members were using the SRS and what instructional strategies student and faculty found to be most valuable to their learning. The term "helpful" and the concept of "helpfulness" is used in place of "valuable" as it more clearly communicates to students and faculty the concept of how an SRS is of worth to them. Students were generally positive about the helpfulness of the instructional methods professors were using. Students found the ability to receive immediate feedback on their learning as the most helpful aspect of the SRS. They also felt their comprehension of course material, attendance to lecture, attentiveness/engagement during lecture, participation in lecture, and achievement in the course had increased from using the SRS. The cost of SRS transmitters had a negative effect on many students' perceptions of the system's overall utility. The least positive students felt that the cost of purchasing the clicker outweighed the benefits of using a student response system. These students rated the instructional methods as less helpful and rated their comprehension, attendance,

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engagement, participation, and achievement increasing less than those that felt the cost was worth the benefit.

Keywords

Evaluation; student response system; instructional methods; student perceptions.

Introduction

The Center for Teaching and Learning (CTL) at Brigham Young University (BYU) became interested in student response systems (SRS) several years ago. A student response system is a combination of hardware and software that allows students to respond to questions posed by the instructor. Students answer questions posed in class using a handheld transmitter. Student responses are collected by a receiver that is attached to the instructor's computer. The results are compiled instantly by the software and charts summarizing the results can then be displayed for the entire class. After different systems were explored and piloted the iClicker system was selected for campus-wide adoption and the CTL was charged with evaluating the implementation to develop an understanding of limitations and best practices that could be shared with faculty in the future. The evaluation took place Winter semester 2007 (January to April 2007).

The primary purpose of the evaluation of the student response system at Brigham Young University was to evaluate how well the technology (hardware and software) of the new system was functioning and how well the system met the needs of professors and students. The CTL also identified the need to provide instructional support to professors about ways of using a SRS in their course. The reason for this was because professors would call the CTL asking if they should start using a SRS in their course and ask for information about how other professors have used it or advantages of using one. The CTL did not have information about this to provide to professors and so requested the evaluation also address how professors are using the SRS and what instructional practices with the SRS students perceived as helpful. This article focuses on the results from the evaluation of students' perceptions of the helpfulness of the instructional methods being used with the SRS and if students felt there were benefits to using a SRS in class. There were several evaluation questions (EQ) that guided the evaluation of the instructional methods, which including the following:

- EQ1. What instructional methods used with the SRS do students find helpful?

- EQ2. Do students feel using a SRS has increased their comprehension of course material, attendance at lecture, attentiveness/engagement during lecture, participation in lecture, and achievement in the course?

- EQ3. Do students feel the cost of purchasing the clicker is worth the benefit they receive from using it?

The stakeholders' evaluation criteria for the instructional methods used with the SRS included that (1) students should perceive the instructional methods being used with the SRS as helpful; (2) students should feel using the SRS has helped increase their attendance to lecture, comprehension of course material, achievement in the course, participation in lecture, and attentiveness/engagement during the lecture; (3) students should perceive benefits of using the SRS no matter their demographics (i.e., year in school); and (4) students should perceive the benefits of using a SRS as worth the cost they pay for the transmitter (see Table 1).

Table 1
Criteria and Evaluation Questions Answered

Criteria	Evaluation questions that will answer the criteria
(1) Students perceive the instructional methods being used with the SRS as helpful.	EQ 1
(2) Students feel using the SRS has helped increase their: attendance to lecture, comprehension of course material, achievement in the course, participation in lecture, and attentiveness/engagement during the lecture.	EQ 2
(3) Students perceived benefits of using the SRS no matter their year in school.	EQ 1
tudents perceive the benefits of using a SRS as worth the cost they pay for the clicker.	EQ 3

Many studies have been conducted on student response system use in higher education; however, only a few discuss specific instructional methods students found helpful (Graham, Tripp, Seawright, & Joeckel, 2007). The studies described the instructional methods that were used, but would generally ask students about areas such as if they felt their interaction in class or class preparation had increased or tried to measure a change in students' achievement or other areas (Draper & Brown, 2004), but did not specifically ask students about the helpfulness of the instructional methods used.

The use of the student response system in higher education dates back to the 1960s, although the popularity of using such systems on university campuses has increased since the mid-1990's (Judson & Sawada, 2002). When student response systems were initially introduced at universities, learning theory and behavioral objectives were primarily focused on a behaviorist approach to learning. Educators were mostly concerned with the systems ability to provide instant feedback to students and professors. Even today much of the use of these systems focuses around the immediate feedback these systems can provide. Back then, as is still common now, instructors would use the feedback to aid in the flow of instruction, adapting their lectures according to responses from students (Judson & Sawada, 2002). These approaches are still used today in university lecture halls. However, much of the research from the 1960s and 1970s did not show any significant differences in mean achievement between students in control sections and students in treatment sections using the SRS that employed these methods. Data from exams and other assessments did not provide support for increased academic achievement from the use of the SRS; although, students provided strong support for the SRS in many studies. Other benefits emerged from students' reports such as positive attitudes toward

the class, feeling the system was useful, feelings of increased understanding, and increased attendance even though there was no evidence of increased achievement in the course (Judson & Sawada, 2002).

Recent research on the use of student response systems has shifted its focus from a behavioral stimulus-response approach to creating interactive learning environments in the classroom employing more constructivist oriented approaches. Current trends in learning theory and research have no doubt contributed to this shift, but the reasons for adopting student response systems still vary. Common reasons (Draper, Cargill, & Cutts, 2002) for current adoption of a SRS include increasing student engagement in large lectures (Beatty, Gerace, Lenoard, & Dufresne, 2006), improving student performance (Liu, Liang, Wang, & Chan, 2003), increasing teacher-student and peer interaction (Silliman & McWilliams, 2004), providing immediate feedback from students to teacher (Barrett, Bornsen, Erickson, Markey, & Spiering, 2005), guiding learners through the material (Williams, 2003), monitoring of individual students from responses (Draper, Cargill, & Cutts, 2002), improving retention and demographic comparisons (Judson & Sawada, 2002), enhancing group discussion (Blackman, Dooley, Kuchinski, & Chapman, 2002), facilitating group discussion in large lectures (Greer & Heaney, 2004, Woods & Chiu, 2003), assessing teaching and learning methods in real time allowing professors and students to gauge student understanding (Wit, 2003), increasing student engagement (Silliman & McWilliams, 2004), and using it for classroom administration techniques (Liu, Liang, Wang, & Chan, 2003; Silliman & McWilliams, 2004).

Despite the varied reasons for adopting a SRS for in-class use, many researchers have recognized the need to focus on the effective underlying pedagogy of using the system. (Judson & Sawada, 2002; Draper & Brown, 2004). Judson & Sawada (2002) state the purpose of their review of the research on student response systems is not to show incorporating technology as the key, but to point to the instructional practices of educators using such a system. Wit (2003) stated, "Introducing technology in the classroom just for the sake of it does not necessarily help the learner and can be sheer folly" (p. 14). With the current shift in focus to the underlying pedagogy of using student response systems and many different reasons for using the systems, there are many instructional methods that may be used. As discussed earlier, the behaviorist approach in the early years of its use has been replaced with a more constructivist oriented approach to the instructional methods (Judson & Sawada, 2002). Much of the focus of the instructional methods is on creating an interactive learning environment for students and moving away from the traditional large lecture format of *talking at* students for the entire period with students passively listening, which is seen as a weak method because of the lack of interactivity (Draper & Brown, 2004). With the variety of instructional methods to be employed with a SRS, instructors should realize that there are many factors along with the instructional methods they use that may contribute to the success of their learning outcomes from using a SRS (Draper & Brown, 2004). However, the instructional methods used are still a significant contributor and so must be carefully selected.

Participants

Participants in the evaluation consisted of professors using the student response system iClicker and students in these professors' classes at Brigham Young University. There were approximately 600 students (freshmen, sophomores, juniors, and seniors) and 16 professors in this group.

Data Collection Methods

Data was collected from students in ten courses that were using the SRS via an online survey and through six focus groups held during Winter semester 2007. There were approximately 2,000 students in this group of ten courses. Generally, the courses were science courses (physical science, physics, physiology, psychology, etc.). The survey asked students to rate their perceived degree of helpfulness of 11 instructional methods and asked them if they felt their comprehension, attendance, engagement, participation, and achievement in the course had increased as a result of using the SRS. Students were then asked to rate how much they agreed with the following statement, *the cost of purchasing the clicker is worth the benefit I received from using one in-class*. The focus groups asked students open-ended questions about what instructional methods they found helpful and if they felt the previously mentioned five areas increased from using the SRS. Table 2 shows each data collection method, data collected, and what evaluation question it was designed to answer.

Table 2
Criteria, Evaluation Questions Answered, and Data Collection Method

Criteria	Evaluation questions that will answer the criteria	Data Collection Method	Data to be collected
(1) Students perceive the instructional methods being used with the SRS as helpful.	EQ 1	Student focus groups and online survey.	Student's ratings (quantitative) on the helpfulness of specific instructional methods being used with student response systems. Qualitative data on instructional methods students perceived as helpful.
(2) Students feel using the SRS has helped increase their: attendance to lecture, comprehension of course material, achievement in the course, participation in lecture, and attentiveness/engagement during the lecture.	EQ 2	Online survey and student focus groups	Student's ratings (quantitative) on how much they felt 5 areas increased because of using a SRS. Qualitative responses on if students felt 5 areas increased because of using a SRS.

Criteria	Evaluation questions that will answer the criteria	Data Collection Method	Data to be collected
(3) Students perceived benefits of using the SRS no matter their year in school.	EQ 1	Online survey	Demographics of the students (year in school)
udents perceive the benefits of using a SRS as worth the cost they pay for the clicker.	EQ 3	Online survey	Student's ratings (quantitative) of if they felt the benefit they received was worth the cost of purchasing the clicker.

Data Analysis

The focus in analyzing the data was to examine themes or trends regarding what students said about the helpfulness of specific instructional methods and if they felt using a SRS had increased their comprehension of course material, attendance at lecture, attentiveness/engagement during lecture, participation in lecture, and achievement in the course and then determine if trends in students' ratings of helpfulness of the instructional methods and those five areas corresponded with trends in how the professors were using the SRS.

Results

The results have been organized around the three evaluation questions. The first section describes the results from data collected about students' perceptions of the helpfulness of the instructional methods used with the SRS. The second section describes the results of areas students' felt had increased as a result of using the SRS (comprehension, attendance, engagement, participation, and achievement). The last section describes the results of data collected about students' perceptions of the cost of purchasing the clicker being worth the benefit they received.

Evaluation Question 1: Helpfulness of Instructional Methods

EQ1. What instructional methods used with the SRS do students find helpful?

In order to address the evaluation question above, students' responses to 11 survey questions and responses from the focus groups from one open-ended question were examined. Table 3 contains the 11 instructional methods that students were asked to rate the helpfulness of on the survey. These eleven methods were developed from an analysis of a prior preliminary evaluation done at the center. This table has been included to give the full description as contained in the survey and the abbreviation as contained in the figures and tables in this chapter.

Table 3
Instructional Methods from the Student Survey

Full description of instructional method from survey	Abbreviation of instructional method for Table and Figures
Asking questions that check if you did the reading	Check for reading
Using it to encourage attendance	Encourage attendance
Asking questions to test how well you understand the course material	Test understanding of course material
Receiving credit for trying to answer the questions even if you get them wrong	Receiving credit for trying
Asking questions to guide topics covered in class	Guide topics in class
Asking questions to get discussions started in class	Start discussions
When the professor tells you to work with your neighbor to answer the clicker questions	Work with your neighbor
Receiving feedback immediately (seeing if you got the answer right or wrong) about how well you understood the material	Immediate feedback
Using the clickers for in-class simulations (research experiments, polling, voting, etc).	In-class simulations
Using it to administer quizzes in class	In-class quizzes
Using it to ask questions during test reviews in class	Test reviews

Overall results of instructional methods. Overall students' mean ratings of the helpfulness of the instructional methods were positive. Every mean rating for each instructional method was over 3.00, which was designated as *somewhat helpful* on the Likert scale. The highest mean rating among the instructional methods was for *receiving immediate feedback*, $M = 4.63$, $SD = 0.73$. The lowest mean rating was for using the SRS to *start class discussion*, $M = 3.60$, SD 1.14. The other instructional methods' mean ratings fell somewhere between these two. Interestingly, immediate feedback was the focus of instructional methods when the use of student response systems was beginning in the 1960s (Judson & Sawada, 2002) and received the highest overall mean rating of students' perceptions of its helpfulness in this evaluation. Receiving immediate feedback was also one of the most frequently stated helpful instructional methods by students in the focus groups. One student said, "I like being able to take quizzes with it in class. I like being able to see how well I did right then, ask the question see the answer." Another student cited the systems ability to provide feedback to the instructor as well as the students,

I would say its helped me a ton when he goes over a concept and then quizzes you on it to make sure you really understand it and if you see right then the results as well then you know you don't actually understand the concept then he can review right then seeing whether the students understand or not.

The most frequently stated instructional method students in the focus groups said they found helpful was using the SRS to ask questions about material covered during lecture or on the assigned reading throughout class. There were several reasons given for why they found this instructional method helpful, such as it keeps their attention throughout the lecture, which makes them catch the material

as they go along and helps increase their preparation for class (they do the reading because they know there will be questions on it). Students from the focus groups did not mention much about specific types of questions professors would use to ask questions about the material; however, one student gave a description of types of questions their professor used that they found helpful,

Ours did a lot of critical thinking so he will take the concept that we've just learned and then he'll have 6 or 7 different scenarios and you'll have to say if A does this then B does what? So its really helpful in getting you to think more than just A is the right answer- you have to think why A is the right answer. It's really helpful.

The similar instructional method of using the SRS to test students' understanding of the course material from the survey received an overall mean rating of $M = 4.19$, $SD = 0.87$. It was the fourth highest rated instructional method by students.

From the overall responses from the survey and focus groups, receiving immediate feedback in class appears to be the instructional method students find most helpful. However, in the focus groups asking questions throughout class was also frequently cited as being a helpful instructional method. Students find asking questions on the course material and reading helpful; additionally, as stated by students in the focus groups, dispersing the questions throughout the lecture is also helpful to them.

Results by professor. When we asked students to rate the helpfulness of the instructional methods on the survey, we also asked them to tell us which class they were in so we could see how students' ratings varied according to professors participating in the evaluation. We did this to see if there were differences in students' ratings based on which class they were in, which could help inform us more about the specific instructional methods each professor was using with the SRS. Descriptive statistics (mean and standard deviation) were computed for each group of student responses by what professors' class they were in. By examining the mean rating for each professor there is a similar trend of *immediate feedback* as generally having the highest mean rating across professor (Figure 1 the heavy blue line with squares). *Using the clicker to get discussions started in class* generally has the lowest mean rating across professor (see Figure 1, heavy brown line with circles) as was the result from the overall mean ratings.

Figure 1
Line graph of mean ratings of instructional methods grouped by professor
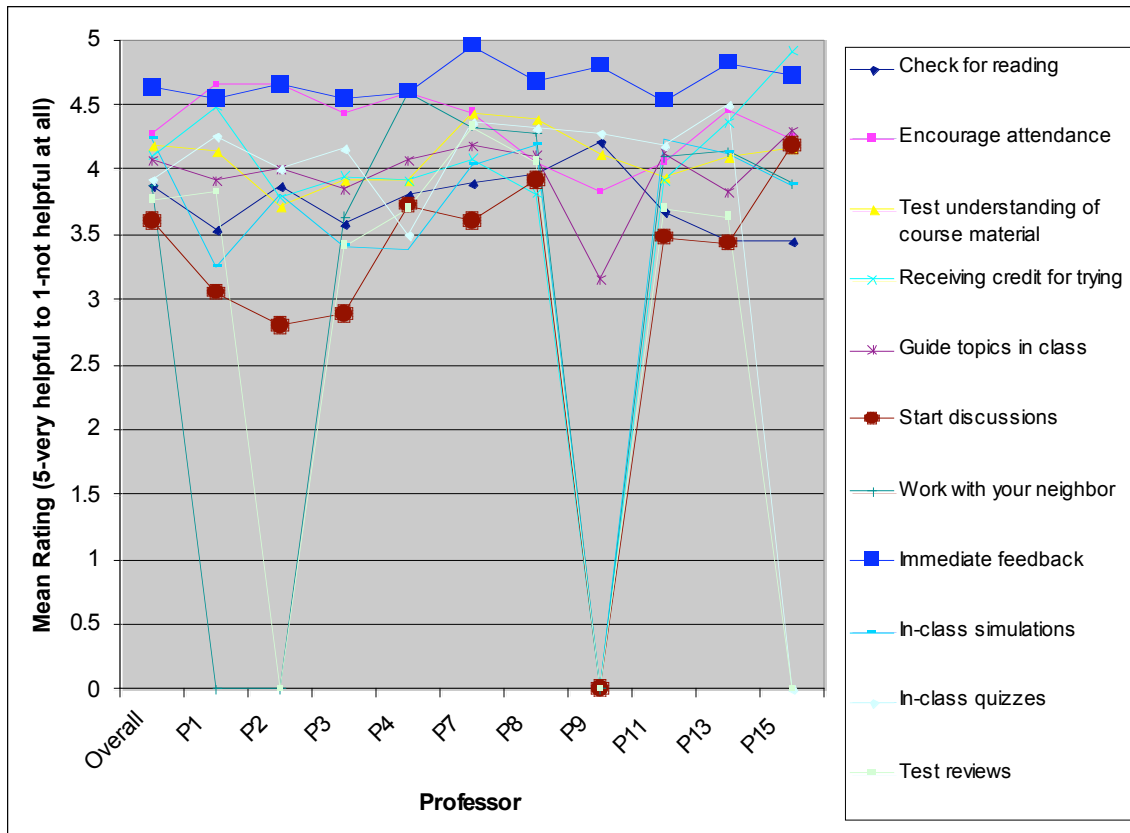

In addition to the trends from the overall results that continue into each individual professor, there is more information from the survey that provides insights into how the SRS was used and how that seemed to affect students' perceptions of the helpfulness of those instructional methods. Under professor P9 in Figure 2 it shows that students' mean ratings of the helpfulness of the instructional methods that were used in this professor's class are generally lower (Figure 2, orange line with circles represents P9) than the other professors' mean ratings. Professor P9 used the SRS strictly for assessment, meaning students had to get the answer right in order to get any points. There were also fewer instructional methods employed by this professor and the SRS was only used four times during the semester. The other professors used the system more often, in more ways, and not strictly for assessment, but also awarded points for participation. This suggests that using the SRS more frequently, in a greater variety of ways, and not strictly for assessment increased students' perceptions of the helpfulness of the instructional methods used with the SRS.

Professor P9 represents an outlier among the ten professors in this group. Many of the professors (P3, P4, P7, P8, P11, and P13) used the SRS in very similar ways. Most used all of the 11 general instructional methods we asked students about. They also used a combination of grading methods,

awarding points for participating and for selecting the correct answers at times, and would re-explain material following a clicker question.

Figure 2
Mean ratings of the instructional methods used by each professor
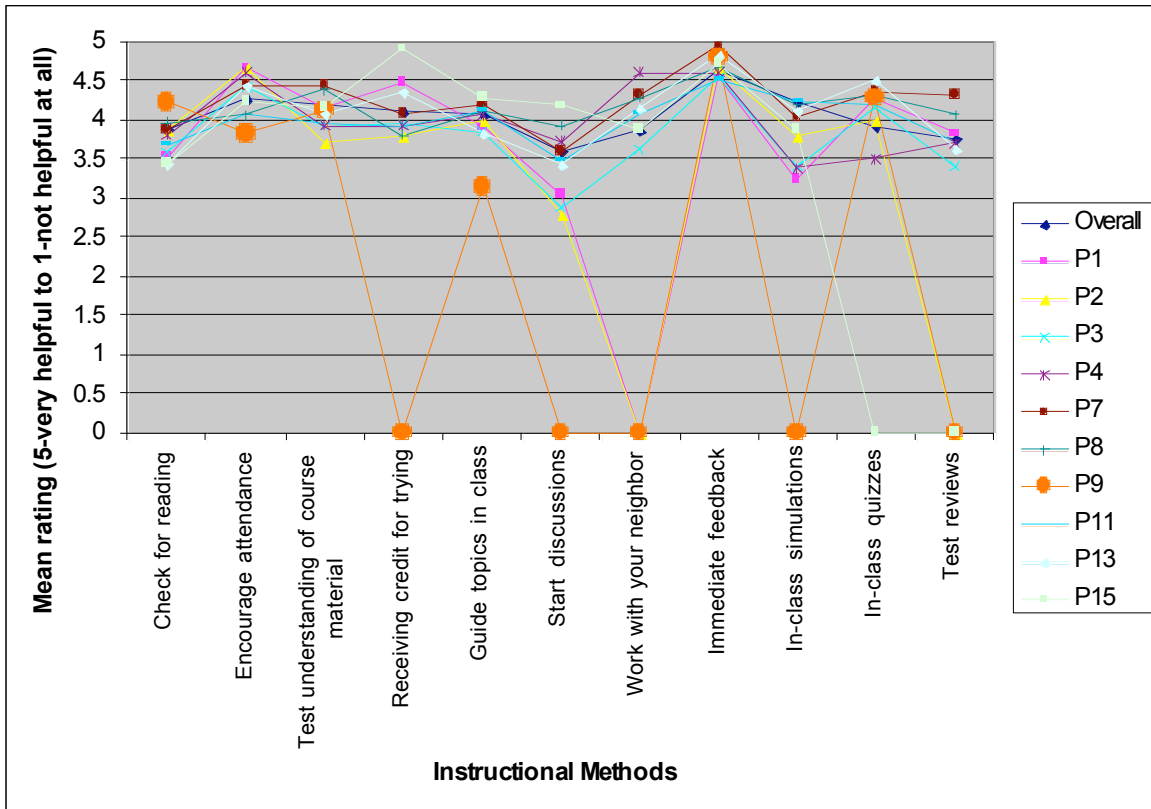
Professors' who used the SRS in similar ways is illustrated by student's mean ratings across instructional methods following a very similar path (see Figure 3). All of the professors in this group taught a subject in the natural sciences and all had a large class size, so there were similarities in addition to the instructional methods they used. The similar mean ratings simply show that even across class and professor, when the SRS was used in similar ways, students generally perceived about the same helpfulness.

Figure 3
The professors who used the SRS in very similar ways as shown by students' mean ratings of the helpfulness of the instructional methods from the survey.
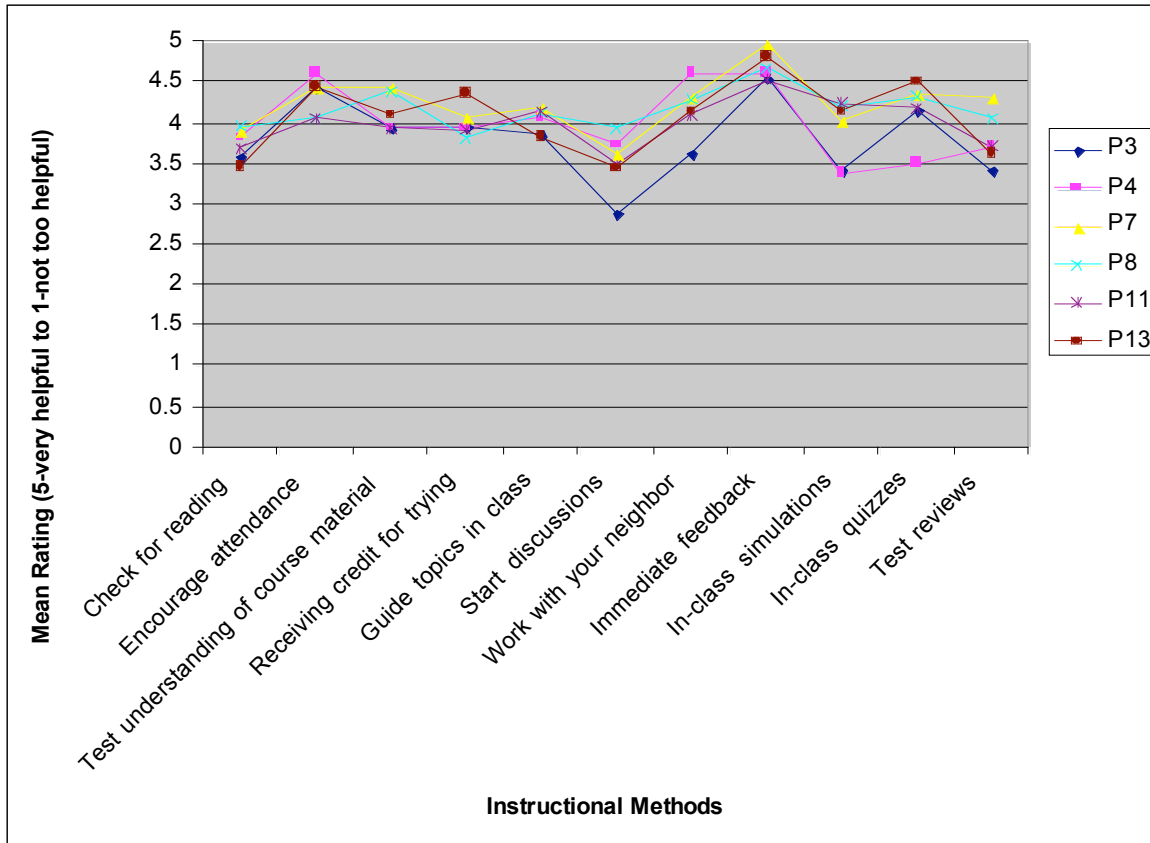
Evaluation Question 2: Areas Students Feel Using SRS has Increased

EQ2. Do students feel using a SRS has increased their comprehension of course material, attendance at lecture, attentiveness/engagement during lecture, participation in lecture, and achievement in the course?

In order to address the evaluation question above, student responses to five questions on the survey and five questions from the focus groups were examined.

Overall results. When all student responses were examined, a*ttendance at lecture* was the area with the highest mean rating, $M = 3.96$, $SD = 0.80$. *Achievement in the course* had the lowest mean rating of $M = 3.59$, $SD = 0.69$. The lower mean rating in *achievement in the course* could also be due to the difficulty in measuring achievement or determining if this one factor (using a SRS) contributed to the students' achievement. As one student stated from the focus group, "I wouldn't know if it has contributed to my achievement because I don't have a similar class that is not using them to compare

it with." Attendance seems to be an easier construct to measure and determine what factors can motivate it. Despite the lower mean rating of *achievement in the course* its mean rating is still above 3.00, which on the Likert scale was *has remained the same*. It appears that, overall, students perceive the use of the SRS as having somewhat of a positive effect on their achievement in the course.

In the focus groups, students were also positive about the effects of the SRS on their comprehension, attendance, engagement, participation, and achievement in the course. Students' responses (*n*=47) in each of these areas generally had twice as many students responding that using the SRS increased the area than those who said it did not (Figure 4). Several students reported that it helped increase their comprehension because the immediate feedback let them know what they needed to study more. One student said, "When we do our quizzes I usually find out I don't know what I'm doing and so I know that I'm doing it wrong." Another student cited the discussion that follows the questions and feedback is also helpful in understanding their own knowledge, "I was going to say because the professor has a period where you have to discuss it and kind of discussing it you either learn to understand or you understand what you don't understand."

Figure 4
Student responses from the focus groups about whether they felt the 5 areas
increased as a result of using the SRS.
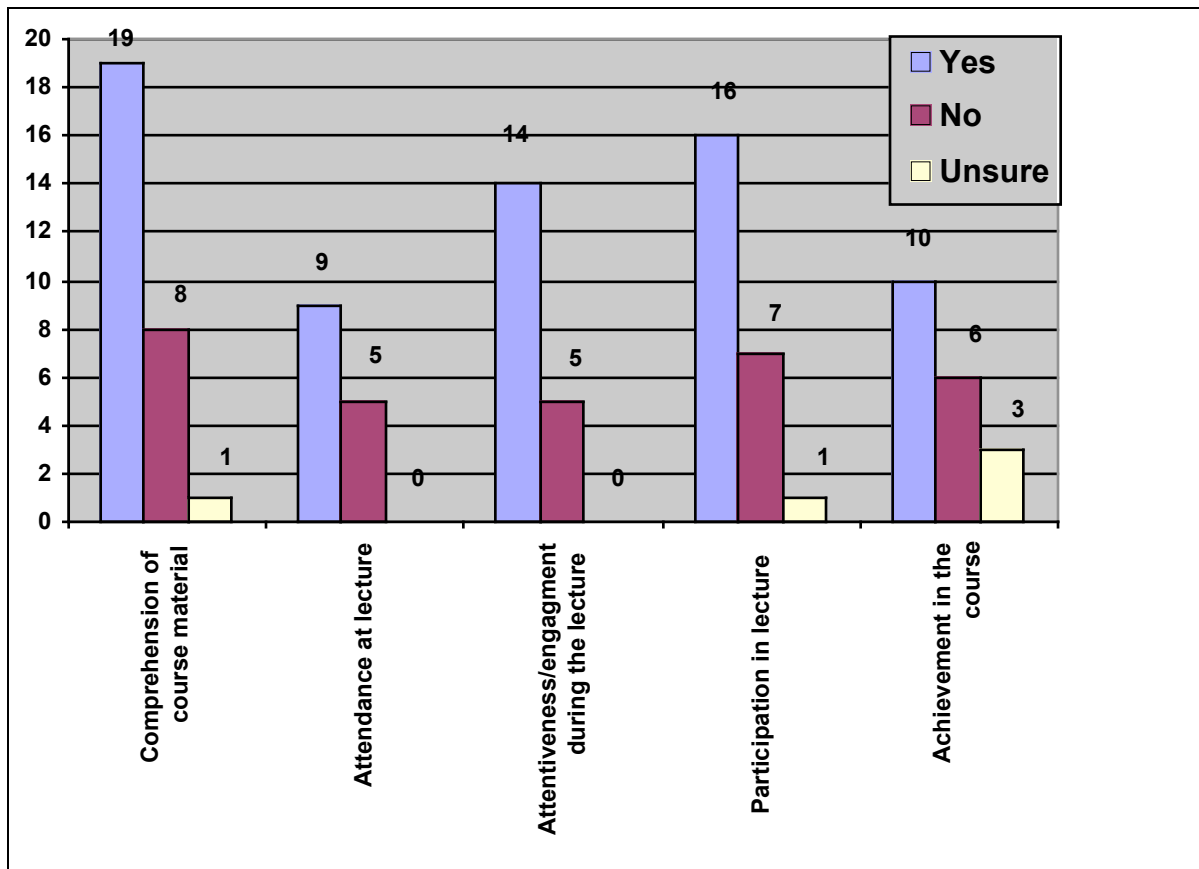
The majority of students did say that they felt using the SRS had helped increase their attendance. Major motivators were the points from quizzes or participating. Some students reported they would go regardless of the SRS use or points. Even though this area had the highest mean rating, it was the area that was the least responded to and least talked about in the focus group. Attendance is easier to measure but may not be seen as important an issue to students as the SRS helping increase their comprehension of the material or achievement in the course and so discussed it less in the focus groups. When students were asked about increasing their attentiveness or engagement they reported working together in groups was helpful. One student said, "Sometimes it's good because you can work in these groups and understand stuff but other times if you're just doing an individual quiz it might not be as engaging." Many students said that they do not fall asleep in class because they know that there are going to be questions/quizzes. They also said that it helped increase their participation because when they would get an answer wrong they would want to know why and so would ask more questions. Students said they felt more confident asking questions when they could see other students' responses and see that others were thinking the way they were. Many of the students that felt using the SRS in class helped increase their achievement in the course said it did because the clicker questions were similar to ones on the tests and so helped them in their test preparation or knowing what types of questions the professor would ask on the test. One student said,

On like the test it always helps because my teacher uses a lot of clicker questions on the exams of that unit so that helps a lot. And he will put them on his website before as a review so it helps.

Overall, students are positive about the use of the SRS helping increase those five areas.

Results by professor. The results from this section follow a similar trend as in the overall results. Generally, *attendance at lecture* (Figure 5, pink line with circles) had the highest mean rating across professor and *achievement in the course* (Figure 5, purple line with squares) had the lowest mean rating.

Figure 5
Students mean ratings divided by professor of how they felt the 5 areas increased as a result of using the SRS.
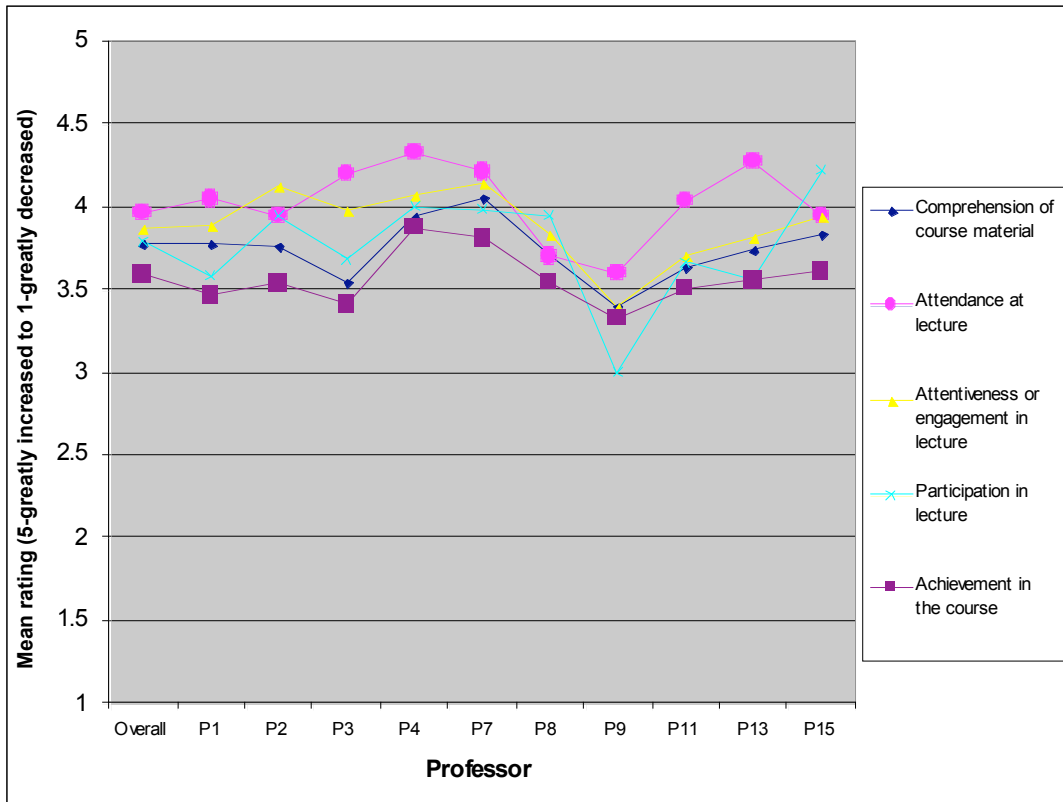
Under professor P9 (see Figure 6) there is a dip in the mean ratings from the survey across these five areas. This professor's students generally rated these five areas not increasing as much as other professors who used the SRS more frequently and employed a wider variety of instructional methods. This is the same professor whose students generally rated the helpfulness of the instructional methods lower than students in other classes that were using the SRS more and in more ways (see Figure 4).

Figure 6
Mean ratings of how much the five areas increased across professor.
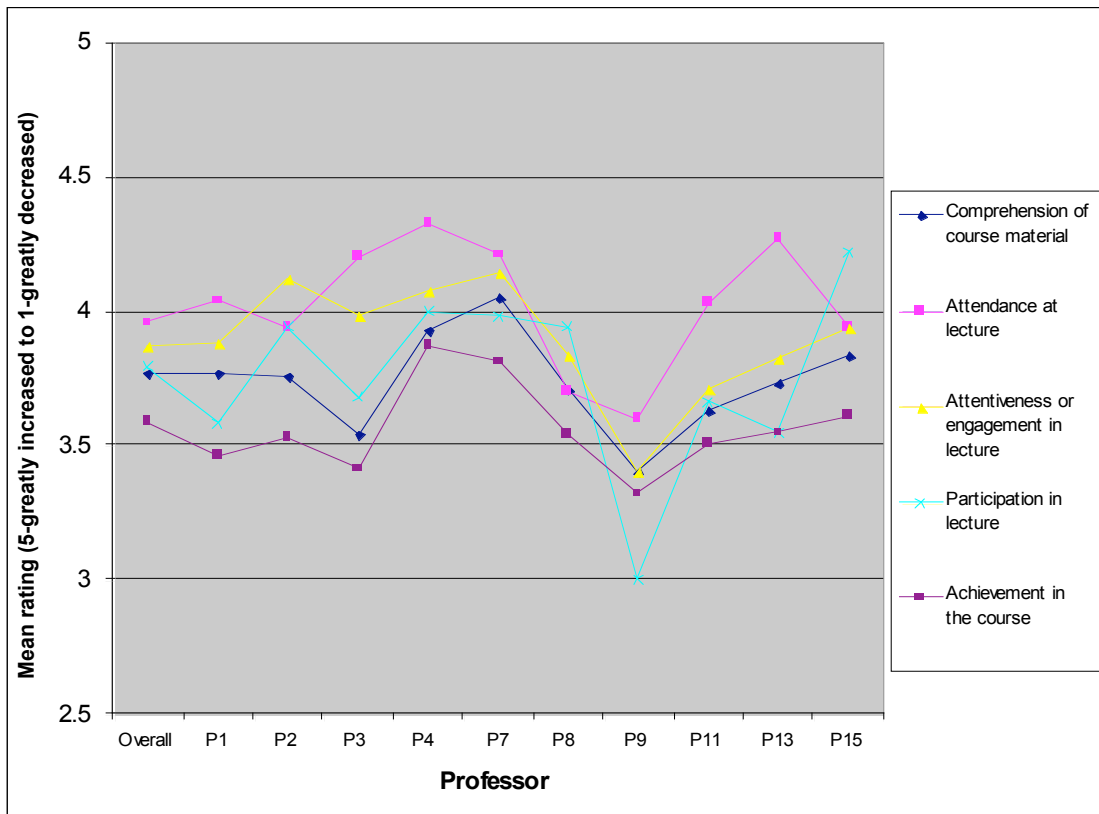
From the survey results grouped by individual professor it appears that students felt these five areas increased more when the SRS was used more frequently, more instructional methods were used, and points were not solely administered based on the correctness of the response.

Evaluation Question 3: Cost of Purchasing the Clicker

EQ3. Do students feel the cost of purchasing the clicker is worth the benefit they receive from using it?

In order to address the evaluation question above, students' responses to one survey question were examined. In all but one class involved in the evaluation, students had to purchase the clicker with their own money in the bookstore. The clicker cost students approximately thirty-five dollars. On the survey, students were asked how strongly they agreed with *the cost of purchasing the clicker being worth the benefit they received from using the SRS in class*. The overall mean rating was *M* = 3.61, *SD* = 1.43. The overall mean ratings fall between *somewhat agree* and *somewhat disagree* rankings, which is not particularly positive towards the cost being worth the benefit students felt they received from using the SRS.

A statistically significant positive correlation was found when students' mean rating across instructional methods were correlated (Pearson r Correlation) with how strongly they agreed with the cost being worth the benefit, $n = 558$, $r = .487$, $p = .000$. As students agreed more strongly with the cost of the clicker being worth the benefit, their mean rating of the helpfulness of the instructional methods also increased. As they disagreed more with the cost being worth the benefit, their mean ratings of the helpfulness of the instructional methods also decreased. This same trend continues for each of the five areas (comprehension of course material, attendance at lecture, attentiveness/engagement during lecture, participation in lecture, and achievement in the course). The Pearson Correlation also yielded a statistically significant correlation between students' mean rating of the five areas and how strongly they agreed with the cost being worth the benefit, $n = 558$, $r = .538$, $p = .000$. The more strongly students agreed with the cost being worth the benefits they felt they received, the more they rated the five areas as increasing as a result of using the SRS. The more strongly they disagreed with the cost being worth the benefits they received from using the SRS, the less they rated these areas as increasing as a result of using the SRS in class.

When students' responses were grouped by what professor they had, professor P9 had the lowest mean rating from students of the cost of purchasing the clicker being worth the benefit they received. Other professors (P3, P4, P7, P8, and P13) who used the SRS more frequently and in more ways had higher mean ratings from students (see Figure 7).

Figure 7
Students mean rating of the cost of purchasing the clicker being worth the benefit they felt they received from using the SRS by professor.
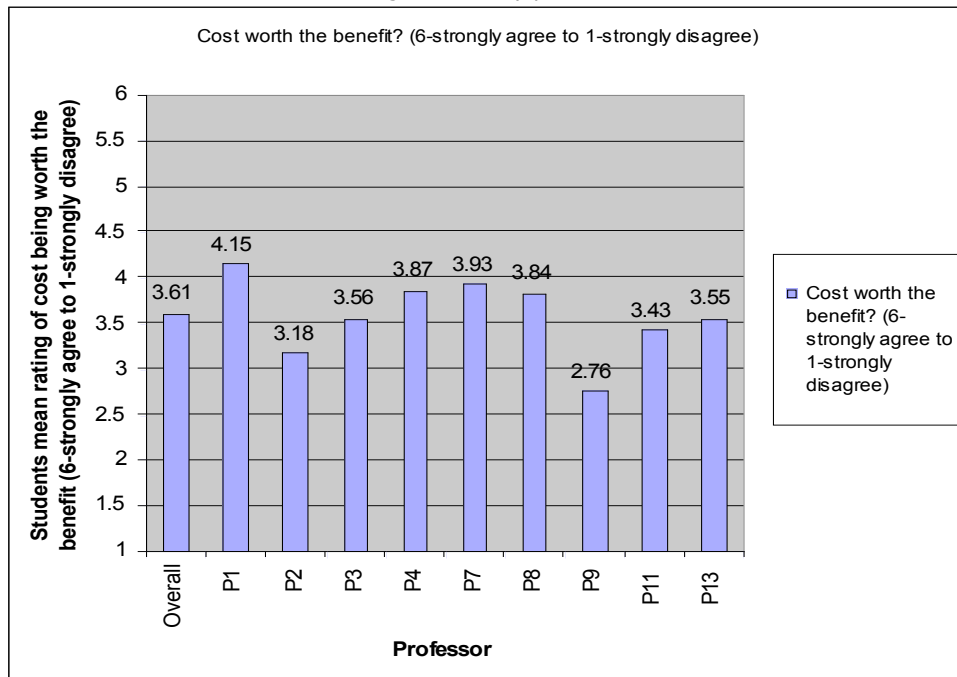
The cost of purchasing a clicker appears to be a significant factor in students' ratings of the helpfulness of using a student response system practically and statistically. Students may have been predisposed to start out with a more negative perception of the SRS because they were required to purchase the transmitter at the beginning of the semester before they understood the purpose of it and how it could help them. Deciding if the students will be responsible for the cost of the clicker or if the department/course will be responsible for the cost is an important factor to consider when implementing one of these systems. However, simply using the SRS more frequently, in more ways, and not strictly for assessment appears to have a positive influence on how students feel about the cost of purchasing the clicker.

Conclusions

Students were generally positive about the helpfulness of the instructional methods used by their professors. The two instructional methods students perceived as most helpful were providing immediate feedback and the ability to answer questions about lecture and reading material throughout the lecture. Students also felt that using the SRS had helped increase (to some degree) their comprehension of course material, attendance at lecture, attention/engagement during lecture, participation in lecture, and achievement in the course. It appeared that students felt using the SRS was more helpful when it was used frequently, when multiple instructional methods were used, and when it was not used strictly for assessment. The cost of purchasing a clicker was a large disadvantage for students and appears to influence their perceptions of the helpfulness of using a SRS. Still, many students did perceive using a SRS to be helpful to them.

The results of this evaluation do provide helpful insights into the use of a SRS and students' perceptions of the helpfulness of using such a system; however, care must be given to not misinterpret the data by placing absolute qualifications on it. The data on students' perceptions of the helpfulness of the instructional methods is not meant to give the final word, but to provide general guidance, and it should be noted that the information is based on students' perceptions. More investigation is needed to if stakeholders wish to gain more specific results of effective instructional methods and the affect on students.

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