THE EFFECTS OF AN AUDIENCE RESPONSE SYSTEM (ARS) ON ACHIEVEMENT AND ATTITUDES TOWARDS STATISTICS IN AN INTRODUCTORY STATISTICS CLASS

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Audience Response Systems are devices that allow for instant communication and involvement by the students in the classroom by the use of handheld remotes. The system allows students to anonymously respond to questions posed by the instructor. A study was done in the Spring of 2009 to test the impacts of using these remotes in a learning disabled classroom. Two sections of Introduction to Statistics I were taught identically except for the use of the handheld remotes: one of these sections used a handheld remote to respond to questions; whereas, the other class discussed the answers to the questions as a class. In addition to looking at graded assessments, each student took the Survey of Attitudes Toward Statistics 36+ Pre and Post Test. The impact of using the remotes on graded assessments and attitudes towards statistics will be compared in the paper as well as recommendations for future study.

PURPOSE

The purpose of this study was to determine the effect of using an audience response system, remotes, in the classroom on student performance and attitudes. This paper will discuss the remotes, the design of the study, and the assessments used. Finally, a discussion of the findings and ideas for future research are included.

THE REMOTES

Remotes are handheld devices similar to a television remote that students use to respond to questions asked by the instructor. The students' responses are picked up by a receiver, recorded by a computer and summarized in a chart showing the results to each question and displaying it on a projection screen. The remotes allow instructors to be able to get an understanding of how well the class understands a topic in a short amount of time. It also allows the students to access how well they understand a particular subject in comparison to the rest of the students.

BACKGROUND

Remotes are a relatively new technology that can be used in small to large classrooms. They are certainly fun to use in class, but do they also provide a pedagogical benefit? Do the remotes help instructors meet the goals of an Introductory Statistics class? A study of these goals is discussed in a paper by Garfield, Hogg, Schau and Whittinghill (2002). They suggest that the "desired outcomes of an introductory course include the following categories: learning (student's understanding, reasoning, thinking), persistence (leading students to use their statistical knowledge and skills after they leave the course) and attitudes and beliefs (about the value and importance of statistics and about themselves as learners and users of statistics" (Garfield, Hogg, Schau & Wittinghall, 2002, para. 8). This study will look at two of these goals - learning and attitudes. Research suggests that students' attention spans can't last the full length of a class period (MacManaway, 1970). Breaking up the lectures into more easily digestible bites increases student learning (Middendorf & Kalish, 1996). Remote questions are a way to do this. Peppering the lecture with remote questions could renew student's concentration and thus foster better learning. Secondly, the GAISE (Guidelines for Assessment in Statistics Education) College Report encourages instructors to foster active learning in the classroom (Aliaga et al., 2005). One of the ways to do this is by using remotes because it requires the students to think and actively respond– not just to listen to the instructor. Another goal of statistics instructors is to change the attitudes of students in the classroom about statistics so they feel that statistics is useful. With these goals in mind, this study will try to answer several questions. Is the use of remotes associated with a higher performance on graded course assessments? Did the use of remotes result in a positive change in

In C. Reading (Ed.), *Data and context in statistics education: Towards an evidence-based society. Proceedings of the Eighth International Conference on Teaching Statistics (ICOTS8, July, 2010), Ljubljana, Slovenia*. Voorburg, The Netherlands: International Statistical Institute. www.stat.auckland.ac.nz/~iase/publications.php

attitudes towards statistics? More specifically, does using the clickers in class make students feel that they are more mentally competent in statistics or perhaps lessen the negative feelings (affect) towards statistics?

SETUP OF STUDY

In the spring of 2009, the instructor taught two sections of introduction to statistics, one section had 25 students and the other section had 20 students. This course was offered out of the Statistics Department in the College of Liberal Arts and Sciences at the University of Florida, a research institution. Both sections were non-statistics majors and were registered with the office of disabilities. The student's learning disabilities were quite diverse. Some of the disabilities included ADD (Attention Deficit Disorder), reading comprehension problems, and dyslexia. In both sections, between one to three multiple-choice questions were asked each class period.

The first section of the day did not use the remotes in class; however, they did see and discuss the questions as a class. The second section of the day answered the questions using the remotes. In both sections, the students were encouraged to discuss the questions with their neighbors. Students were encouraged to not only give what they thought was the answer, but to also explain and justify their answer.

The section that used the remotes was graded on the accuracy of their responses. If they got the question correct, they earned 2 points and if they answered, but got the question wrong, they earned 1 point. If they did not answer the question at all they did not receive any points.

Both sections of students were given the same lecture and exposed to the questions and answers both in class and on the internet after the questions were presented in class. To the extent possible, the only difference between the two sections was the fact that the second section was graded using the remotes as they answered the questions in class.

ASSESSMENTS

Each student in the course signed an IRB consent form and elected whether their grades on assessments could be used for research purposes as well as their results of an attitudes survey. The assessments consisted of 12 homework assignments, 12 quizzes, 7 labs and 4 tests. The students were also given surveys (pre and post) about their attitudes towards statistics. The attitudes survey used was the Survey of Attitudes Toward Statistics–36+ by Schau (2003). The survey asked the students to respond to a comment using a 7 point Likert Scale, where 1 is strongly disagree, 4 is neither disagree nor agree and 7 is strongly agree. For example, a few sample statements on the survey were "I will like Statistics", "Statistics is worthless", and "I plan to complete all of my statistics assignments" (Schau, 2003, p. 1). The responses to the statements could be combined to form six attitude components. These components are affect, cognitive competence, value, difficulty, interest and effort. The first four components were a part of the first SATS test, SATS -27. They can be defined as "(a) Affect–positive and negative feelings concerning statistics; (b) Cognitive Competence–attitudes about intellectual knowledge and skills applied to statistics; (c) Value–attitudes about the usefulness, relevance, and worth of statistics in personal and professional life; and (d) Difficulty – attitudes about the difficulty of statistics as a subject" (Schau, Stevens, Dauphinee, & Del Vecchio, 1995, pp. 869-870). The other two components, interest and effort were added later and were a part of SATS-36+. These components are defined as "Interest – student's self reported level of individual interest in statistics and Effort – amount of work students say they expend to learn statistics" (Schau, 2003, p.33). The higher the attitudes score the more positive the student's attitude. For example, a high affect score means that the students have more positive feelings. The difficulty component is the exception. The higher the difficulty score the easier the student thinks statistics is to learn (Schau, 2003).

RESULTS

The students in both sections took the same tests at a common time at night. They also completed the same 7 labs, 12 homework assignments, and 12 similar quizzes.

Table 1. Summary of Graded Assessments by Remote Use

Assessments	Remote Section (n = 17)	Non-Remote Section (n = 10)
Test 1	Mean = 72.91 s = 18.79	Mean = 72.84 s = 14.82
Test 2	Mean = 81.14 s = 15.94	Mean = 80.77 s = 14.27
Test 3	Mean = 78.07 s = 18.04	Mean = 73.85 s = 20.55
Test 4	Mean = 81.24 s = 13.81	Mean = 82.01 s = 10.84
Overall Lab Grade	Mean = 92.30 s = 11.76	Mean = 89.24 s = 9.03
Overall Quiz Grade	Mean = 86.35 s = 9.35	Mean = 83.02 s = 13.49
Overall Homework Grade	Mean = 84.70 s = 26.21	Mean = 78.65 s = 18.47
Overall Grade in Class	Mean = 81.43 s = 11.63	Mean = 79.53 s = 11.64

The sample means were higher in the remote section in seven out of the eight assessments. A MANOVA analysis was conducted with the explanatory variable being use of remotes (yes or no) and the response variables being the individual test scores, overall lab grade, overall homework grade and overall quiz grade. The p-value for Wilks, Lawley-Hotelling, and Pillai's tests was 0.838; therefore there is not statistically significant evidence that the means are different for the remote and the non-remote groups for the various assessments.

The component scores for each of the different subcategories of attitudes were also recorded. For each student, the change in their subscore was found by taking the Pre test score minus the Post test score and then averaged. So, the negative means below represent that the post score was higher.

Table 2. Summary of Attitude Scores by Remote Use

Assessments	Remote Section (n = 15)	Non-Remote Section (n = 13)	Two Sample t p-value
Interest*	Mean = - 0.250 s = 1.150	Mean = 1.135 s = 1.663	0.02
Effort	Mean = 0.167 s = 1.216	Mean = 0.500 s = 1.874	0.589
Affect	Mean = - 0.544 s = 1.270	Mean = - 0.051 s = 1.490	0.360
Cognitive Competence	Mean = - 0.578 s = 1.118	Mean = 0.115 s = 0.941	0.087
Value*	Mean = - 0.163 s = 0.978	Mean = 0.812 s = 0.969	0.014
Difficulty	Mean = - 0.533 s = 0.861	Mean = 0.077 s = 1.117	0.124

The change was quite small in both groups. The means in the remote section were "more negative" than in the non-remote section suggesting that the post test scores were higher. These subcomponents were compared separately as recommended by Macnaughton (2003). A two sample t test was conducted to see if the mean change in pre and post test was different for the two groups for each attitude. This suggests that the change from pre to post test was significantly different for the interest and the value subcomponents between the remote and non-remote groups.

COMMENTS BY STUDENTS

The students were also asked to answer four short answer questions. One of these questions was "How did the remotes influence your participation/experience in this course?" The following comments were selected to characterize how students reacted to using the remotes:

- … the overall concept made me want to think about the answer and try to solve it without giving up.
- The remotes made you cover information that would be on the exams; caused you to think quick and help you practice on a daily basis.
- A lot because it's either you know it or you don't and that helps you to be more confident in your answers,
- It made me think on my toes and helped me to recall information in my head. It also helped reinforced what I learned the previous day.

- It made me pay more attention therefore I participated more. I think that they are good because the teacher can then explain the problem if nobody understood it.
- I would not have come to class if we didn't have remotes.
- I feel like the remote helped only a little.

Although not completely positive, the statements generally reflect that the students found the remotes helpful.

LIMITATIONS OF THE STUDY

There are two limiting factors for this study. Because each student has a registered learning disability, the class size is kept small. This may have affected the ability of the study to determine statistical significance. Additionally, the students were not randomly allocated to the remote and non-remote group. Randomly allocating students would have negatively impacted the student's schedules and potentially their progress toward a degree.

CONCLUSION

Although there is no statistically significant evidence that the remote class performed better than the non-remote class, the means of the assessments suggest that there may be some impact. In terms of the attitude scores there was a statistically significant difference between the remote and non-remote group in terms of interest and value.

IDEAS FOR FUTURE RESEARCH

Since the findings in the project do not suggest a major difference in the assessment scores for the use of remotes in the classroom when questions are asked randomly throughout the time period, the next step in the study is to see if an alternative questioning technique is more affective at changing students' ability to learn and their attitude toward the subject. During an upcoming semester the authors plan is to conduct a modified version of the study to see if a different technique increases the students' performance and improves their attitudes toward statistics.

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