Students Opinions of a Student Response System for Introductory Packaging Classes

Rafael Auras[1], Valentina A. Bali[2], and Laura Bix[3]
Michigan State University
East Lansing, MI 48224-1223

Abstract

Student response systems (SRSs) were used during the spring and fall semesters of 2006 in two introductory packaging classes, PKG 101 and PKG 221 at Michigan State University, to routinely ask questions in class and then display the students' responses in real time. At the semester end, students' opinions regarding the system were collected (using the SRSs) and then analyzed. Their likelihood of preferring a class with SRSs was estimated by fitting a probit model with student demographics (gender, major, and course grade) as predictor variables.

Across the two classes, 82% of students or more claimed that the SRS motivated them to attend class, and 58% or more stated it motivated them to participate and listen. In addition, students stated that SRSs enhanced their classroom experience (62% or more) and helped them to study (47% or more). Overall, students who preferred a class with SRSs were 34% of PKG 101 students and 62% of PKG 221 students. To sum, students were particularly motivated to attend class, but their overall preference for the SRSs varied by class.

With regards to the correlates of preference for SRSs, three main inferences can be taken from this study. 1) Demographic factors such as gender and grade were not indicated to significantly affect the likelihood that a student liked the SRS; 2) students within the course major (Packaging) were more likely to prefer a class with an SRS; and 3) class characteristics and/or the implementation of SRSs can play a critical role on the likelihood that students will like the use of SRS in class.

Keywords: Student Response Systems, Audience Response Systems, Clickers, Students opinion, Educational Technology.

Introduction

Student response systems (SRSs), also called clickers or student-polling systems, are tools that seek to create a more active learning environment in large classes by allowing students to interact. They are known by varied names, including: audience-paced feedback systems (APF), audience response system (ARS), classroom performance system (CPS), electronic response system (ERS), hyper-active teaching technology (H-ITT), interactive engagement (IE), interactive audience response systems (IRIS), interactive learning systems (ILS), interactive student response systems (ISRS), personal response systems (PRS), peer response system (PRS), group response system (GRS), wireless response system (WRS), personal response system (PRS), and classroom response system (CRS) (Auras and Bix, 2007; Lowery, 2005). Regardless of terminology, they are a growing technology in K-12 and higher education classrooms throughout the world (Barber and Njus, 2007; Kay and LeSage, 2009; MacArthur and Jones, 2008).

In principle, SRSs facilitate the interaction between faculty members and students on an ongoing basis by allowing instructors to ask multiple choice, true/false and numerical questions during class and then display the anonymous responses in the aggregate in real time. Additionally, SRSs allow for the collection of attendance data and provide immediate feedback to the students on their grasp of the material and to the instructor on student understanding of presented concepts. As a result, these systems can be used as an assessment of both teaching and learning in real time.

SRSs consist of three basic components: a student input device (keypad), an operating system software loaded onto the instructor's classroom computer, and an overhead projection system that displays the questions asked and the distribution of student responses (Figure 1 shows a pictorial view of a model system). The data generated during classes can be collected and recorded in a computer or web-based software. For an entire description of different SRSs see the following references (Lowery, 2005; Auras and Bix, 2007; MacArthur and Jones, 2008; Kay and LeSage, 2009; Barber and Njus, 2007).

The use of SRSs have been reported to increase student attendance (Fies and Marshall, 2008), attention (Kay and LeSage, 2009), engagement and interaction (Caldwell, 2007; Trees and Jackson, 2007), discussion (Draper and Brown, 2004), and student performance (Caldwell, 2007; Crossgrove and Curran, 2008; Suchman et al., 2006). Moreover, SRSs have been linked to assessment benefits such as improving the just-in-time feedback process (Beatty, 2004), providing more formative assessments (Beatty, 2004; Caldwell, 2007), and allowing the comparison of understanding across students (Caldwell, 2007; Kay and LeSage, 2009). They have

[1]School of Packaging; Telephone: 517.432.3254; E-mail: aurasraf@msu.edu
[2]Political Science Department
[3]School of Packaging

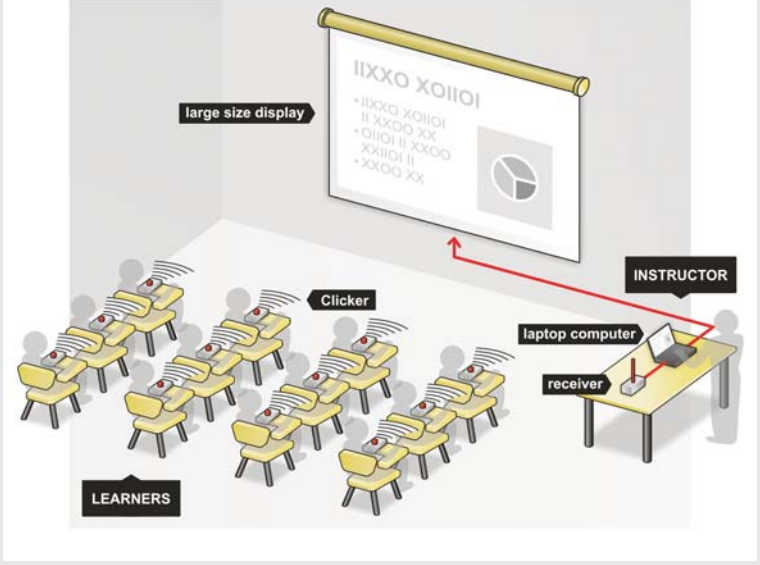

Figure 1. Typical configuration of student response systems.

been indicated to be a particularly useful tool for large classroom settings (MacGeorge et al., 2008).

Most of the current research has centered on demonstrating the gains in learning due to the implementation of SRSs. They have been correlated with more effective, learner-centered environments that leverage a more "active atmosphere" (Caldwell, 2007; MacGeorge et al., 2008). Although research evidence varies regarding the degree that SRSs improve students' learning (Caldwell, 2007; Crossgrove and Curran, 2008; Gauci et al., 2009; Trees and Jackson, 2007), most scholarship finds that SRSs help students' attendance and participation (Caldwell, 2007; Fies and Marshall, 2008; Kay and LeSage, 2009; Smith and Rosenkoetter, 2009; Trees and Jackson, 2007). Therefore, a large number of higher education institutions are implementing SRSs (Auras and Bix, 2007; Lowery, 2005; Smith and Rosenkoetter, 2009). Increasing implementation of the systems by higher education promotes research regarding the acceptance of this new pedagogical tool by the students that must invest in them (Lowery, 2005; MacGeorge et al., 2008; Smith and Rosenkoetter, 2009). The objective of this work was to examine students' opinions of an SRS utilized in two introductory packaging classes at the School of Packaging (SoP), Michigan State University (MSU; East Lansing, MI).

Materials and Methods

Implementation of an SRS at the School of Packaging

PKG 101 (Principles of Packaging) is an introductory course taught every semester on campus and online. Because there are no specific prerequisites, PKG 101 frequently serves to fill elective credits for varying majors, some related to packaging (such as Marketing) and others less directly so (such as Animal Science). As a result, the backgrounds, interests, and engagement levels of students enrolled in the class vary widely. By contrast, students in PKG 221 (Glass and Metal Packaging) are primarily packaging majors, and those that are not are generally in fields for which the presented topics are relevant (Food Science, etc.).

In both classes, approximately 10 minutes before the beginning of class, the instructor setup and initialized the SRS by plugging the receiver (see Figure 1) into an available universal serial bus port on a laptop system, starting the projection system, booting the computer, and then starting the presentation system (PowerPointTM in this case). After this, the instructor started the SRS software, which triggered a "join screen," allowing the students to register their presence by clicking a specific sequence on their transmitter. This procedure was the same for both classes.

Once the join-session was closed, students that had logged on were able to use the SRS to answer questions posed throughout the lesson. Students were only able to log their SRS in while the join screen was active (at the beginning of class), so they had to be on time to log participation for a particular class session.

In both PKG 101 and 221, one or two questions were routinely asked at the beginning to review the previous class. For PKG 101, generally four to six more questions were scattered throughout the remaining 1 hour and 20 minute session. For PKG 221, two to three questions were asked at intervals of around 15 to 20 minutes throughout its 50 minute session.

Data presented here reflects MSU students' opinions of the SRS as reported in end-of-semester surveys carried out in each of the two classes (PKG 101 and PKG 221) upon completion of two different semesters (spring 2006 and fall 2006). Methodologically, the data were examined through tabular analyses as well as multivariate analyses detailed below.

SRS Survey Administration

At the close of the spring and fall semesters of 2006, students in both PKG 101 and 221 were surveyed using the SRS to obtain student feedback regarding the implementation and use of the systems (IRB #06-123, 2006). Eight questions were posed which sought to address students' opinions related to the use of SRSs. Questions were meant to explore various aspects of system using, including: attendance, participation, comprehension of the material, class enhancement, and overall preference for the clickers (for exact wording see later Tables 1 and 2). Additionally, after the semester ended and final grades had been submitted, an e-mail was sent to the

students who had signed an informed consent form in order to obtain open-ended responses regarding the use of SRSs in packaging education.

Statistical analyses

The collected data from students that had signed a consent form was analyzed using tabular breakdowns and multivariate analyses. The tabular analyses consisted of cross-tabulations between the eight questions and three student characteristics: gender, major, and class grade. That is, students' responses to each question were broken down in percentages for the whole sample, and then for males and females, non-packaging majors and packaging majors, and students with a GPA less than 2.5 and those with a GPA more than 2.5. Difference between two-sample proportions tests were carried across student characteristics (e.g., comparing males versus females, packaging versus non-packaging students, etc.) for each response. For example, 54% of males in PKG 101 answered that they were motivated to participate in class by the clickers compared to 67% of females. The corresponding proportions, 0.54 and 0.67, were then tested statistically with a two-sample differences in proportions test and found to be statistically different at the $\alpha = 0.05$ level. For a full description of proportion tests see Freund and Wilson (2003). The statistical significance in the proportions' differences was assessed using both $\alpha = 0.05$ and $\alpha = 0.10$ levels.

The multivariate analyses were conducted to predict a student's preference for a class with an SRS as a function of student characteristics (gender, major, and class grade) and opinions on the remaining questions. The dependent variable is discrete and binary, with "1" indicating a strict preference for a class with an SRS, and "0" indicating either indifference or preference of a class without the SRS. Ordinary least squares (OLS) regression is not appropriate under these circumstances since the dependent variable is not continuous. Probit models are used specifically when the dependent variable is discrete and binary, as in the present case. Coefficients that link the independent variables to the discrete outcomes are estimated using maximum likelihood estimation, with positive coefficients interpreted as increasing non-linearly the probability of a positive outcome (or a "1"). For example, if the coefficient for being a Packaging Major is 0.41 in the present probit model with a p-value of 0.07, this suggests that at the $\alpha = 0.10$ level, being a packaging major increases the probability of preferring classes with clickers. Since the effect is non-linear, the exact increase in probability needs to be computed and cannot be read off directly from the coefficient, as can be done with OLS regressions. A detailed description of a probit model can be found elsewhere (Greene, 2008). The probit model predicting the likelihood of a student preferring a class with an SRS was estimated with STATA, version 10.0 (College Station, TX, USA).

Initial multivariate analysis of the data indicated that the class, whether PKG 101 or PKG 221, had a significant effect on students' preference for an SRS ($p=0.08$). This suggested that aspects related to the class, such as, the SRSs' implementation by the faculty, class content, or students selection into a class, could mediate students' opinion of SRSs. Therefore, to make sure that the results were properly presented, and that the aggregate data did not occult class effects the responses from students were analyzed separately by class.

Results

The characteristics of students enrolled in PKG 101 and PKG 221 during the two semesters of interest are presented in Figure 2. A total of 181 students were enrolled in PKG 101 during the spring 2006 semester and 165 during the fall 2006 semester. Of these students, 66% (spring) and 52% (fall) consented to participate in the study. In PKG 221, a total of 94 students were enrolled during spring 2006 and 82 students during fall 2006, of which 64 and 65% consented to participate, respectively. Female students, students with a class grade higher than 2.5, and packaging majors were more likely to provide consent than other groups.

Demographically, females represented 30 to 40% of respondents in these classes across semesters, with lesser female representation occurring in PKG 221. Reflective of the nature of the class, only 23% (spring) and 38% (fall) of PKG 101 respondents were declared Packaging majors, while 87% of respondents were declared majors in the PKG 221 class during both reporting semesters. The majority of PKG 101 respondents 52% (spring) and 80% (fall) had a grade point average of 2.5 or higher. The same held true for PKG 221 respondents, who comprised 68% of the spring sample and 79% of those responding in the fall semester. Thus, when contrasting the composition of PKG 101 and PKG 221 classes, the most significant difference is in terms of the percentage of packaging majors, which is larger for the more advanced class.

Tables 1 and 2 present the aggregate responses to each of the questions by PKG101 and PKG 221 students, respectively, over the two semesters. The percentages are from the total number of respondents for the first column, and then from each given sub-samples (e.g., males, females, packaging majors, etc.). As with any human subject study, subjects were not required to participate in all aspects of the study, but could drop in and out of participation as they wished. As a result, the number of total respondents changed slightly from question to question.

Focusing first on PKG 101, students reported that the use of SRSs motivated them to attend class (82%), to participate and listen (58%), and in general SRSs enhanced their classroom experience (62%). However, in this class some aspects of the SRS drew less than majoritarian support: only 43% of the students considered the instructor to be more

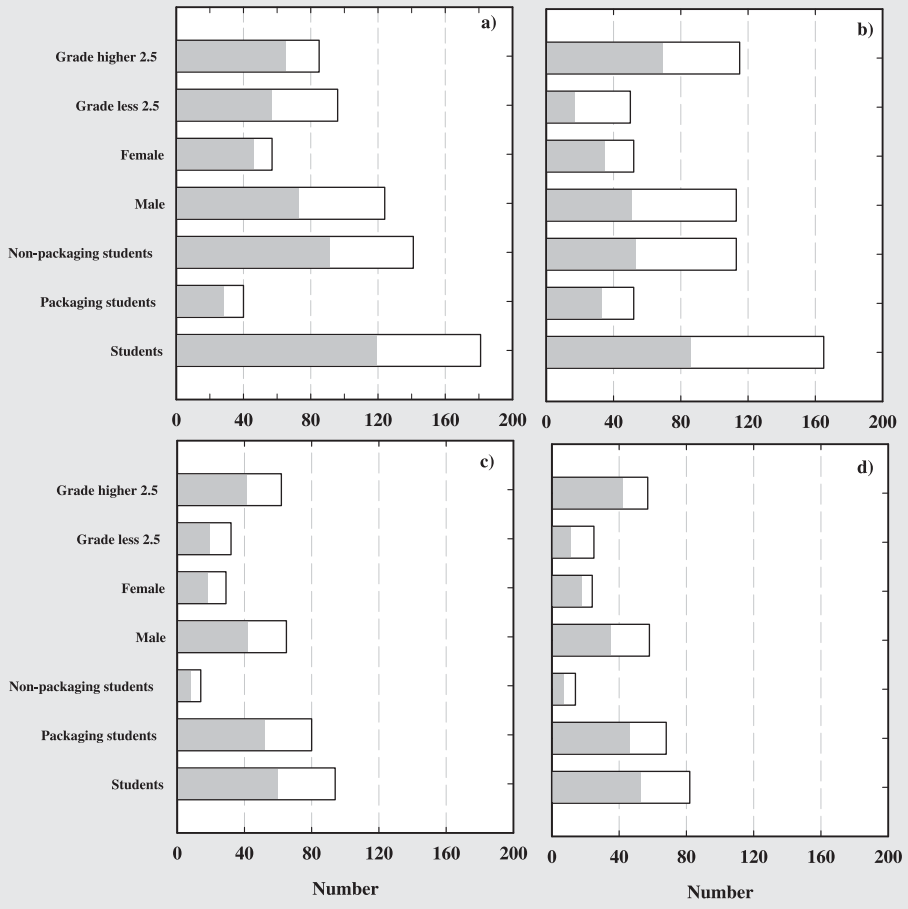

Figure 2. Student demographics; white and gray color bars indicate total number of students and consent students, respectively; a) PKG101 SS06, b) PKG101 FS06, c) PKG221 SS06, d) PKG221 FS06.

organized when the SRS was employed, 48% of the students reported that the SRS helped them to understand the material, and 47% indicated that SRS questions helped them to study. Overall, 34% of PKG 101 students preferred a class with clickers, and 44% preferred a class without them.

Relatively few sub-samples indicated evidence of statistically significant differences in the proportions (or percentages) for the PKG 101 class. The most notable difference related to gender. The proportion of females who indicated that the SRS motivated them to participate and listen in class (67%) was greater than the proportion of male respondents (54%), p=0.04. Females also indicated that the questions were helpful during study at a higher proportion than their male counterparts (58 versus 41%), p<0.01.

The vast majority of PKG 221 students reported that the SRS motivated them to attend class (93%), to participate and to listen (78%) in class, and, in general, enhanced their classroom experience (72%). Moreover, a majority also reported that the SRS helped them to understand the class material (65%) and helped the instructor be more organized (65%), and that the questions helped them to study (68%). Overall, 62% of the PKG 221 students preferred a class with clickers and 30% preferred a class without them. As with PKG 101, there are also few notable differences across subgroups for the PKG 221 class.

From the tabular analysis we observe that preference for SRSs varies from 34 to 62% from one class to the other while few demographic differences can be observed. However, to properly account for confounding variation,

Table 1. Cross Tabulation of Student Opinions of Clickers and Selected Covariates in PKG 101, Spring 2006 and Fall 2006

		Percentage (%) of the number of respondents						
		All Sample	Males	Females	Non Packaging	Packaging	Grade less than 2.5	Grade more than 2.5
Q1: Did the clicker motivate you to attend class?	Yes	82.3	81.2	84.4	83.8	77.9	77.6	85.2
	Indifferent	10.4	9.4	12.2	9.4	13.2	9.2	11.1
	No	7.3	**9.4***	**3.3***	6.8	8.8	**13.3****	**3.7****
Q2: Did the clicker motivate you to participate and listen in class?	Yes	58.5	**53.9****	**67.4****	60.3	53.6	53.2	61.6
	Indifferent	13.0	**15.6***	**8.14***	**9.8****	**21.7****	12.8	13.2
	No	28.5	30.5	24.4	29.9	24.6	34.0	25.2
Q3: Did the clicker help you to understand and comprehend the class material?	Yes	47.7	46.7	49.5	44.7	55.7	50.0	46.3
	Indifferent	16.5	15.6	18.3	17.9	12.9	**11.2***	**19.7***
	No	35.8	37.7	32.3	37.4	31.4	38.8	33.9
Q4: Did the use of clickers enhance or disrupt your classroom experience?	Enhance	62.2	59.8	66.7	61.3	64.7	59.2	63.9
	Neither	27.4	27.8	26.7	26.2	30.9	32.6	24.2
	Disrupt	10.4	12.4	6.7	**12.6****	**4.4****	8.2	11.8
Q5: Do you think the questions that were asked were fair?	Yes	90.3	89.8	91.3	90.9	88.7	**85.1****	**93.4****
	No	9.7	10.2	8.7	9.1	11.3	**14.8****	**6.6****
Q6: Do you feel that the instructor was more or less organized as a result of the use of the clicker system?	More	42.6	39.8	47.8	39.9	50.0	38.8	44.8
	No Difference	36.1	35.1	38.0	37.3	32.9	40.8	33.3
	Less	11.8	13.5	8.7	13.5	7.1	11.2	12.1
	Unable to Assess	9.5	**11.7***	**5.4***	9.3	10.0	9.2	9.7
Q7: Did the questions help you in your effort to study the material?	Yes	46.8	**40.6****	**58.4****	45.5	50.7	40.8	50.3
	Indifferent	12.2	14.6	7.9	12.8	10.4	13.9	11.2
	No	40.9	**44.8***	**33.7***	41.7	38.8	45.1	38.5
Q8: Do you prefer a class with or without clickers?	With	34.1	32.6	37.1	31.8	40.6	37.0	32.3
	Indifferent	22.2	20.9	24.7	21.9	23.2	17.0	25.5
	Without	43.7	46.5	38.2	46.3	36.2	46.0	42.2

Note 1: Differences of proportions tests were carried out by student characteristic: males compared to females, packaging majors compared to non-packaging majors and low GPA students compared to high GPA students, for each question and response. Statistical significance is indicated by ** when at the 0.05 level and by * when at the 0.10 level.
Note 2: For the whole sample of PK 101 students the number of respondents varied between 253 and 261. Male respondents varied between 165 and 176 while female respondents varied between 86 and 93. Non-packaging respondents varied from 184 to 197 and packaging respondents varied between 68 and 71. Respondents with a grade less than 2.5 varied between 93 and 101 and respondents with a grade greater than 2.5 varied between 159 and 162.
Note 3: Column percentages by question may not add up to 100% due to rounding.

Table 2. Cross Tabulation of Student Opinions of Clickers and Selected Covariates in PKG 221, Spring 2006 and Fall 2006

		Percentage (%) of the number of respondents						
		All Sample	Males	Females	Non Packaging	Packaging	Grade less than 2.5	Grade more than 2.5
Q1: Did the clicker motivate you to attend class?	Yes	92.6	92.5	92.9	100.0	91.2	92.6	92.6
	Indifferent	5.3	4.5	7.1	0.0	6.2	7.4	4.4
	No	2.1	2.9	0.0	0.0	2.5	0.0	2.9
Q2: Did the clicker motivate you to participate and listen in class?	Yes	78.0	76.7	74.1	69.2	79.5	76.0	78.8
	Indifferent	6.6	6.3	7.4	15.4	5.1	8.0	6.1
	No	15.4	14.1	18.5	15.4	15.4	16.0	15.1
Q3: Did the clicker help you to understand and comprehend the class material?	Yes	65.6	65.1	66.7	64.3	65.8	69.2	64.2
	Indifferent	11.8	**9.1***	**18.5***	0.0	13.9	3.8	14.9
	No	22.6	25.8	14.8	35.7	20.2	26.9	20.9
Q4: Did the use of clickers enhance or disrupt your classroom experience?	Enhance	72.0	73.8	67.9	69.2	72.5	76.9	70.1
	Neither	18.3	**12.3****	**32.1****	15.4	18.7	11.5	20.9
	Disrupt	9.7	**13.8****	**0****	15.4	8.7	11.5	8.9
Q5: Do you think the questions that were asked were fair?	Yes	92.6	93.9	10.7	**78.6****	**95.0****	**100.0***	**89.5***
	No	7.5	6.1	89.3	**21.4****	**5.0****	0.0	10.5
Q6: Do you feel that the instructor was more or less organized as a result of the use of the clicker system?	More	64.9	68.2	57.1	57.1	66.2	62.9	65.7
	No Difference	28.7	25.8	35.7	35.7	27.5	29.6	28.4
	Less	4.3	4.5	3.6	0.0	5.0	7.4	2.9
	Unable to Assess	2.1	1.5	3.6	7.1	1.2	0.0	2.9
Q7: Did the questions help you in your effort to study the material?	Yes	68.4	68.7	67.9	64.3	69.1	66.7	69.1
	Indifferent	8.4	**5.9***	**14.3***	7.1	8.6	7.4	8.8
	No	23.2	25.4	17.9	28.6	22.2	25.9	22.1
Q8: Do you prefer a class with or without clickers?	With	62.4	63.1	60.7	64.3	62.0	70.4	59.1
	Indifferent	7.5	9.2	3.6	7.1	7.6	3.7	9.1
	Without	30.1	27.7	35.7	28.6	30.4	25.9	31.8

Note 1: Differences of proportions tests were carried out by student characteristic: males compared to females, packaging majors compared to non-packaging majors and low GPA students compared to high GPA students, for each question and response. Statistical significance is indicated by ** when at the 0.05 level and by * when at the 0.10 level.
Note 2: For the whole sample of PKG 221 students the number of respondents varied between 91 and 95. Male respondents varied between 65 and 67 while female respondents varied between 27 and 28. Non-packaging respondents varied between 13 and 15 and packaging respondents varied between 78 and 81. Respondents with a grade less than 2.5 varied between 25 and 27 and respondents with a grade larger than 2.5 varied between 66 and 68.
Note 3: Column percentages by question may not add up to 100% due to rounding.

multivariate analyses need to be carried out. So, two different probit models were fitted for each class to predict students' preference for a class with clickers, as seen in Table 3.

Table 3. Probit Models Predicting a Student's Preference for a Class with Clickers (Question 8)

	PKG 101 Model 1		PKG 101 Model 2		PKG 221 Model 1		PKG 221 Model 2	
Dependent Variable: "1" prefers class with clickers and "0" is indifferent or prefers class without clickers								
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Student Characteristics								
Female	0.150	0.38	-0.194	0.37	-0.016	0.96	0.052	0.90
Packaging	0.251	0.16	**0.415**	**0.07**	0.059	0.88	-0.741	0.28
Grade Less 2.5	0.162	0.33	0.324	0.13	0.316	0.32	0.474	0.32
Student Opinions								
Price is Too High			-0.355	0.16			0.497	0.32
It should not Cost			**-0.971**	**0.01**			0.839	0.41
Q1 Answered yes (Attendance)			-0.198	0.46			0.014	0.98
Q2 Answered Yes (Participation)			**0.355**	**0.10**			0.697	0.15
Q3 Answered yes (Comprehension)			0.035	0.87			0.712	0.18
Q4 Answered Yes (Enhance Class)			**0.765**	**<0.01**			**1.031**	**0.02**
Q5 Answered Yes (Fair Questions)			0.684	0.20			1.108	0.24
Q7 Answered Yes (Study)			0.202	0.33			0.468	0.36
Constant	-0.593	<0.01	-1.617	0.01	0.181	0.66	-2.569	0.02
Number of respondents		261		215		93		85
Pseudo R^2		0.009		0.18		0.008		0.404
LR Statistic		3.24		49.03		1.09		45.09
	Prob[Chi_3^2 <LR]= 0.35		Prob[Chi_{11}^2 <LR]=0.0001		Prob[Chi_3^2 <LR]= 0.78		Prob[Chi_{11}^2 <LR]= 0.0001	

Note 1: Coefficients in bold achieve statistical significance at the 0.10 level or less.
Note 2: The Pseudo R^2 is a measure of goodness of fit for discrete models which is an analog to the R^2 in regression analysis. The LR statistic compares the likelihood of a model without predictor variables to one with all the predictor variables. Smaller values of the statistic, which can be linked to a Chi ^{2} distribution, indicate we cannot reject the hypothesis that all factors have no influence (for more details on these measures of fit see Greene 2008, P. 498 and P. 790 [17]).

Model 1 included student demographic factors (gender, packaging and grade less than 2.5) as predictor variables. In model 2, all the demographic variables were included plus the responses to questions 1 through 5, question 7, and students' assessment of SRS cost (i.e., price is too high and it should not cost). In the case of PKG 101, model 2 indicates that packaging majors were more inclined to like a class with clickers (p=0.07). In addition, PKG 101 students who reported that the SRS enhanced their class experience were more likely to prefer a class with clickers (p<0.01), but if they believed clickers should not cost, they were less likely to prefer them in a class (p=0.01). In the case of PKG 221, no predictor variable was indicated to influence preference for a class with clickers, except for the opinion that SRS use enhanced the class (p=0.02).

Discussion

Faculty observed increased attention and engagement in the classes employing the SRS as has been documented in the literature (Caldwell, 2007; Kay and LeSage, 2009; Trees and Jackson, 2007). Student responses are congruent with this (see Table 1 and 2, Qs 1 and 2). However, not all aspects related to the SRS prompted support of the SRS, or were consistent across the two classes. For example, in terms of SRSs' influence on study efforts, 53% of PKG 101 students indicated the SRS questions did not help them or made a difference to review the material (Table 1, Q 7). By contrast, PKG 221 students were favorably inclined to the SRS in relation to their study. Despite the positive responses to many questions for both classes, and qualitative feedback obtained via email, PKG 101 and PKG 221 students responded differently to Question 8 (i.e., prefer a class with SRSs or not). A majority of PKG 101 students did not prefer a class with clickers (Table 1, Q8), though if they were already packaging majors this inclination was dampened (Table 3, Model 2). If they thought the SRS should not cost, they were then significantly less likely to prefer a class with them (Table 3, Model 2). This begs the question why? Perhaps it relates to the cost of the clicker relative to the benefits that they

provide; or maybe the clickers force accountability in classes that were previously more or less anonymous in nature. Maybe it is related to adoption difficulties that the instructors observed with some students. On occasion, students had difficulties registering the clicker correctly, consistently bringing the keypad to class (some are forgotten, others are lost or broken) and maintaining the system (having fresh batteries on hand, etc.). In the case of PKG 221, where around 85% of the students already belong to the packaging major, they preferred a class with SRSs, and overall they displayed positive responses to Questions 1-7. Since most of the students were already part of the major, they may already be more willing to accept this tool to engage in class and the material, and they may have a higher tolerance for difficulties encountered.

Preszler et al., found that the percentage of students for whom clickers were a distraction or were detrimental gradually increased as grades decreased (Preszler et al., 2007). Moreover, these authors also found that the "students' opinions of the influence of the clickers on their ability to learn the course material also varied by grade" (i.e., students with higher grade thought that the clickers helped them to learn). As shown in Table 3, this study failed to find an effect of class grade on students' preference for an SRS in a class (Question 8) for either PKG 101 or PKG 221.

These findings reinforce previous work conducted by the research team (Auras and Bix, 2007), which suggests that the instructors' approach to using clickers has a profound impact on the success or failure of the implementation. The authors encourage faculty to consider various implementation aspects when introducing and using this tool. Items for consideration include: policy issues (lost, forgotten, broken or malfunctioning equipment, accommodations for visually impaired students, students with anxiety disorders, etc), and assessment issues (points for attendance, credit for participation, points for right and wrong answers, and implementation of peer instruction). A number of authors have explored these topics, and the reference section of this article is a good beginning for looking at implementing SRSs in classes.

Summary

Overall, three main inferences can be taken from this study. 1) Demographic factors such as gender and grade were not found to have a significant effect on the chance of preferring a class with SRSs, 2) students in the packaging major were more likely to prefer a class with SRSs, and 3) class level (i.e., freshman or sophomore in this case) and implementation of SRSs can play a crucial role in students' preference for SRSs.

PKG 101 and 221 students, surveyed during two consecutive semesters, indicated that the implementation of an SRS in their classes motivated them to attend and helped them to comprehend and study the class material. However, PKG 101 students indicated that they preferred classes that did not employ an SRS. On the contrary, most of PKG 221 students indicated that they preferred a class with SRS. Further study is needed to understand this dichotomy. Future efforts should continue to examine the implementation of SRS across classes.

Literature Cited

Auras, R.A. and L. Bix. 2007. Wake up! The effectiveness of a student response system in large packaging classes. Packaging Technology and Science 20: 183-195. DOI: 10.1002/pts.

Barber, M. and D. Njus. 2007. Clicker evolution: Seeking intelligent design. CBE-Life Sciences Education 6: 1-20. DOI: 10.1187/cbe.06-12-0206.

Beatty, I. 2004. Education title: Transforming student learning with classroom communication systems. Educause Center for Applied Research 3(3): 1-13.

Caldwell, J. 2007. Clickers in the large classroom: Current research and best-practice tips. Life Sciences Education 6: 9-20. DOI: 10.1187/cbe.06–12–0205.

Crossgrove, K. and K. Curran. 2008. Using clickers in non-majors and majors level biology courses: Student opinion, learning, and long-term retention of course material. CBE-Life Sciences Education 7(1): 146-154. DOI: 10.1187/cbe.07-08-0060.

Draper, S. and M. Brown. 2004. Increasing interactivity in lectures using an electronic voting system. Jour. of Computer Assisted Learning 20: 81-94.

Fies, C. and J. Marshall. 2008. The C 3 framework: Evaluating classroom response system interactions in university classrooms. Jour. of Science Education and Technology 17: 483-499. DOI 10.1007/s10956-008-9116-4.

Freund, R. and W. Wilson. 2003. Statistical methods, 2nd ed. San Diego, CA: W.J. Academic Press.

Gauci, S., A. Dantas, D. Williams, and R. Kemm. 2009. Promoting student-centered active learning in lectures with a personal response system. Advances in Physiology Education 33: 60-71. DOI:10.1152/advan.00109.2007.

Greene, W.T. 2008. Econometric Analysis. 6th ed. Upper Saddle River, NJ: Pearson Prentice Hill.

IRB #06-123. 2006. Using a student response system in packaging. Michigan State University Social Science/Behavioral/Education Institutional Review Board.

Kay, R. and A. LeSage. 2009. Examining the benefits and challenges of using audience response systems: A review of the literature. Computers and Education 53: 819-827. DOI:10.1016/j.compedu.2009.05.001.

Lowery, R.C. 2005. Teaching and learning with interactive student response systems: A comparison of commercial products in the higher-

education market. http://www.vanderbilt.edu/cft/resources/teaching_resources /technology/crs_biblio.htm. Accessed: December 17, 2009.

MacArthur, J. and L. Jones. 2008. A review of literature reports of clickers applicable to college chemistry classrooms. Chemistry Education Research and Practice 9: 187-195. DOI: 10.1039/b812407h.

MacGeorge, E., S. Homan, J. Dunning, D. Elmore, G. Bodie, E. Evans, S. Khichadia, S. Lichti, B. Feng, and B. Geddes. 2008. Student evaluation of audience response technology in large lecture classes. Educational Technology Research and Development 56: 125-145. DOI 10.1007/s11423-007-9053-6.

Preszler, R., A. Dawe, C. Shuster, and M. Shuster. 2007. Assessment of the effects of student response systems on student learning and attitudes over a broad range of biology courses. CBE-Life Sciences Education 6: 29-41. DOI: 10.1187/cbe.06-09-0190.

Smith, D. and M. Rosenkoetter. 2009. Effectiveness, challenges, and perceptions of classroom participation systems. Nurse Educator 34(4): 156-161.

Suchman, E., K. Uchiyama, R. Smith, and K. Bender. 2006. Evaluating the impact of a classroom response system in a microbiology course. Microbiology Education 7: 3-11.

Trees, A. and M. Jackson. 2007. The learning environment in clicker classrooms: Student processes of learning and involvement in large university-level courses using student response systems. Learning, Media and Technology 32(1): 21-40. DOI: 10.1080/17439880601141179.