Investigating the Effects of Group Response Systems on Learning Outcomes and Satisfaction in Accounting Education

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ABSTRACT

A review of vendor websites indicates numerous claims by proponents about the benefits of group response systems (GRS) on student participation, engagement and performance. GRS facilitate instructor-student interaction through individual student use of electronic response pads, with the student responses then aggregated and displayed by the instructor to provide immediate feedback on class understanding of a particular question. Despite their increasing use and prior research indicating student satisfaction with GRS, there is little empirical evidence of the effect of GRS on learning, measured directly or indirectly through participation or exam performance. This study begins to address this gap by examining the effect of GRS on student learning and satisfaction incremental to the use of an interactive pedagogy in an accounting education context.

We use a between and within subjects experimental design to examine class oral participation and performance on exams where the related classes have been conducted with and without use of the GRS. We also conduct surveys to compare within and between student perspectives on the technology and course with and without the use of the GRS. We find clear evidence of student satisfaction with GRS, but no evidence that this results in improvements in self-reported perceptions of the class more generally. In some cases, self-reported behaviors such as participation decline on a within-subjects basis once the GRS are removed, but are not significantly higher than the reported behaviors of non-GRS users for the same period.

Analysis of objective participation measures indicates no effect of the GRS on the average number of questions answered. Contrary to expectations, we find a weakly significant decline in the average number of questions asked per student when the GRS were used. We also find that on average a smaller percentage of students participated in class when the GRS were used. We find some evidence that exam performance improvement is associated with GRS usage, but only for those exam questions most closely related to the questions displayed in class using the GRS. However, since these questions were displayed to all students, this results suggests the improved performance may be related to some GRS characteristic, rather than just to greater familiarity with the GRS displayed questions.

Our results are contrary to some of the claims being made by vendors of GRS that the technology can have dramatic effects on student engagement. We discuss possible reasons for these findings, and suggest additional research to address some possible limitations of the current study as well as to generalize the results to other settings.

INTRODUCTION

Higher education is constantly under pressure to become both more effective and more efficient. One response to these pressures is deployment of information technology to improve both efficiency and effectiveness. While technology such as e-mail, course websites, and online chat rooms can be used to improve communications with large numbers of students without necessarily affecting pedagogy[1], other technologies are being experimented with specifically to improve student learning. The purpose of this study is to examine the effects of a technology called group response systems[2] (GRS) that is intended to directly improve student engagement and feedback and thus indirectly improve learning. Specifically, we explore the incremental effects of GRS, controlling for pedagogy, on both subjective measures of engagement and course satisfaction (as indicated by student survey responses) as well as on objective measures based on changes in exam performance and student participation.

GRS comprise individual response pads that typically have wireless communication connections to a receiver, which is in turn connected to a computer/data projector combination. Instructors create various types of structured questions (such as multiple choice, true/false, and yes/no questions), using custom software to display them with the data projector. Each student

[1] This statement is not intended to imply that such technologies can not be deployed with changes in pedagogy to improve learning, but rather that the intent in deployment of these technologies is often to provide another medium for communication, and thus to supplement office hours and in-class discussions.

[2] As noted by S. Draper on the website http://www.psy.gla.ac.uk/~steve/ilig/, these systems are also referred to as electronic voting systems, personal response systems (PRS), and classroom communication systems (CCS).

uses his or her response pad to select an answer, which is transmitted to the receiver and recorded. The responses can then be automatically aggregated and displayed to provide immediate feedback on students' individual comprehension as well as the class's understanding. The technology can also be used to poll students and show aggregated opinions to provide a basis for further discussion.

Vendors and users of GRS cite numerous benefits including improvements in student satisfaction, engagement, exam performance and interaction[3]. However, despite these claims, there is limited supporting evidence and little research on whether such benefits lead to improved learning. A number of studies suggest strong student (and instructor) satisfaction with the systems, but almost none have attempted to measure changes in student interaction or investigated objective improvements in learning incremental to the pedagogy being used (Judson and Sawada 2002; Roschelle, Penuel and Abrahamson 2004).

There is interest in GRS technology by accounting educators, as evidenced by learning strategies forum papers at the 2004 and 2005 American Accounting Association (AAA) annual meetings (AAA 2004; AAA 2005), discussion in July in the Accounting Education Using Computers and Multimedia (AECM) electronic mailing list, (AECM 2005), and bundling of accounting textbooks with GRS by publishers such as McGraw Hill. Accordingly, evidence on the value of this technology for accounting education as well as education more generally seems

[3] Examples of these claims can be found at www.einstruction.com and www.gtco.com.

important. Our study is designed to begin to address the identified gaps in the literature to provide evidence concerning the impact of GRS on learning and engagement.

We expect that any learning effects of GRS will primarily arise from the enhanced interactivity the technology provides. Learning frameworks such as those developed by Laurillard (1993; 2002) stress the importance of interactivity as one component in creating a "conversational framework", which includes student practice, instructor feedback, student reflection on the feedback, and tailoring of materials by the instructor to address the problems in understanding revealed by the student responses. We are not claiming that interactivity requires computer technology, but some traditional approaches (such as regular hand-in assignments or involving the entire class in discussion) may be difficult to employ in an era of increasing class sizes and limited marking budgets. A benefit of GRS is that they may increase interactivity, regardless of class size, by having all students immediately respond to and receive feedback for every question, and by enabling instructors to focus on the problems revealed by the question responses. Consistent with Laurillard's (2002) framework, this may result in improved learning.

Our research design collects and analyses two kinds of data. We analyze student responses to surveys to determine student perceptions of the technology and the accounting course more generally, and we collect and analyze objective measures of student participation and exam performance, using within subjects measures of both items with and without the GRS system. Our study extends the GRS literature in three significant ways. First, we have a control

group so that we can compare student general course perceptions with and without GRS. Second, we use an objective measure of student participation (as a proxy for engagement). Third, ours is the only study we are aware of that examines the effects of GRS on objective measures of learning incremental to pedagogy effects. The remainder of this paper is organized as follows: the next section provides a literature review summarizing what is known about the effects of GRS and our resulting research questions to extend the literature, followed by a discussion of our research design and then the analysis of our results. Finally, we summarize our findings, and provide some conclusions and possible limitations of our work.

PRIOR RESEARCH ON GROUP RESPONSE SYSTEMS AND DEVELOPMENT OF RESEARCH QUESTIONS

GRS have been used by a variety of disciplines in universities, including philosophy (logic), mathematics, statistics, engineering, architecture, physics, computing science, psychology, and medicine. Class sizes where the technology has been deployed range from 20 to 500 students per class. As noted earlier, many of the more recent studies of GRS have examined student satisfaction with the technology, with only a few investigating effects on learning as indicated by differences in exam performance.

Student Satisfaction

Judson and Sawada (2002) report that nearly all studies of GRS show high levels of student satisfaction with the technology. For example, Abrahamson (1999) provides results from

a study using GRS in an introductory physics course of 150 students. She notes that 90% of respondents claimed that they understood the subject better, enjoyed classes more, and a somewhat smaller percentage claimed they came to class better prepared and paid more attention in classes. The drop-out rate also decreased. Draper and Brown (2002) report that in a survey of students in a formal logic class of about 140 students where a GRS had been used, 77% of respondents rated the GRS as useful, very useful, or extremely useful. A further study by Draper and Brown (2004) on the results of using a GRS shows that roughly 80% of respondents in a first year computing science course reported that the benefits exceeded the disadvantages of using a GRS. Less than 5% of respondents indicated that there were more disadvantages than benefits. We have not located any studies reporting student dissatisfaction with the technology. However, the studies we have located have not generally used a control group to assess the non-GRS specific measures of satisfaction, such as class enjoyment and paying more attention in class.

Performance Effects

Judson and Sawada (2002) summarize the studies of GRS in the 1960's and 1970's, which deployed the technology with traditional lecture approaches, as finding that the technology was associated with no difference in student performance, despite student reports of strong satisfaction with the technology. Judson and Sawada note that a key difference between early studies of GRS and later studies is whether the technology was used to improve interactivity within the pedagogy being used. The early studies generally used a traditional lecture format,

with the technology used as a means of counting and categorizing student responses and the summarized information provided largely for the instructor's benefit.

In contrast, recent GRS studies such as those done by Cutts et al (2004), Madill (2004, Dufresne et al (1996) and Nicol and Boyle (2003) use the technology to enhance an interactive pedagogy. For example, Nicol and Boyle (2003) compare the effects of two types of interactive pedagogy when used with GRS, but did not examine differences in objective measures of performance (e.g., exam scores). One of the few studies cited as having objective measures of performance change is Poulis et al (1997). This study found that the GRS pass rates were higher in six of the seven topics covered in the course, and the standard deviation of the pass rates were also smaller, suggesting more consistent understanding of the material. This study examined the use of GRS in conjunction with increased student discussion, although it is not clear if the comparison groups used student discussion without the GRS, or a more conventional lecture approach. Another study commonly cited as having demonstrated positive GRS learning effects is that of Hake (1998). Hake found substantially improved performance on standard physics exams by students who had been enrolled in "interactive engagement" courses relative to those enrolled in "traditional lecture" courses. However, it appears likely that many of the interactive engagement courses did not use GRS, so conclusions regarding the impact of GRS on learning based on this study are inappropriate.

The Importance of Interactivity

Judson and Sawada's conclusions, along with the Hake (1998) study, suggest the importance of considering pedagogy when trying to establish the learning effects of GRS. In particular, these and other GRS studies suggest that interactivity is a key determinant of learning. As noted in Dufresne et al, (1996, 3) the construction of student knowledge is "...facilitated by instruction, [but] not the direct consequence of instruction." According to these perspectives, it is the improvements in interactivity afforded by GRS that should improve learning.

While GRS may help create interactivity, it is not the only way to achieve it, and it is possible to use GRS without improving interactivity, as established by the GRS studies of the 1960's and 1970's. This raises questions as to the ways in which pedagogy may be interactive, and how GRS can contribute to each dimension. According to Borsook and Higginbotham-Wheat (1991) an interactive pedagogy has the following key elements: immediacy of response to questions; instructor responsiveness to the needs of the students; performance feedback (outcome and explanatory); and bi-directional communication. The degree of interactivity in different pedagogical approaches ranges from low (e.g., lectures with limited bi-directional communication) to high (e.g., tutorial sessions with immediate feedback and extensive bi-directional communication).

The value of an interactive pedagogy is indicated by studies such as Crouch and Mazur (2001). They report that over a 10-year period with multiple instructors one form of an

interactive pedagogy known as peer instruction resulted in significant increases in learning on a standard exam relative to pre-course results on the same exam. The normalized gain in knowledge more than doubled relative to the gain provided by conventional lecture approaches. However, this and similar studies of interactive pedagogies did not investigate GRS.

Further reinforcement of the importance of interactivity and the ways in which technology can improve this factor arises from the learning framework suggested by Laurillard (1993, 2002). Laurillard's framework stresses the importance of interactivity between the instructor and student for a number of activities viewed as integral to learning, including agreement on learning goals related to the concept at hand, student practice and instructor feedback on their efforts. This should then be followed by student reflection and integration of their learning with their initial understanding, then by subsequent student articulation of this new understanding and additional iterations of the framework.

Taken together, Laurillard's framework and Borsook and Higginbotham-Wheat's (1991) elements of interactivity suggest GRS could improve learning by improving interactivity in several ways:

1. By providing an opportunity and incentive for each student to practice their understanding by developing an answer to the posed question and entering it into the system using the response pad, which is then immediately followed by instructor feedback on the response (outcome feedback) and additional explanation (explanatory feedback).

2. By improving instructor understanding of the variations in understanding between the students and the instructor. This can then provide the basis for subsequent discussion and follow up questions by students and instructor, as well as for additional practice with the GRS.
3. By providing students with information to compare their understanding to that of their peers, which may act as an incentive to reflect on their learning and comprehension.

Synthesis of the Literature and Research Questions To Be Investigated

Research on learning suggests the value of interactive pedagogies across a number of disciplines, but typically does not consider technological supplements such as GRS. The existing research on GRS indicates a very favorable response to GRS technology by students (e.g., high student satisfaction), but little objective evidence of performance effects, perhaps because more traditional lecture formats were usually used. For those studies that do report some learning effects of GRS, it is difficult to disentangle the performance effects related to the use of an interactive pedagogy deployed *in conjunction* with the GRS, from that of the GRS itself.

While there is theory such as that provided by Laurillard (2002), and evidence (e.g., Hake 1998) that more interactive pedagogies do improve student learning, there is little research to support or refute the claim that GRS improve learning *beyond* the changes provided by moving to a more interactive pedagogy. As Judson and Sawada (2002, p. 175) summarize their findings

regarding GRS' effect on student performance, "... the issue of academic achievement remains open."

Given our review of the literature, we investigate whether GRS does have an incremental effect on student performance in the context of accounting education. We also investigate whether student satisfaction with GRS is similar in an accounting educational context to the high levels reported in other disciplines. Although *ex ante* we have no reason to expect accounting students' satisfaction with GRS to differ from the results documented in other disciplines, it is important to assess this point as a poor implementation of GRS (i.e., low satisfaction) could decrease or eliminate any learning benefits.

Our specific research questions are thus as follows:

1. Do GRS, when used with interactive pedagogies, improve student satisfaction (as measured by in-class surveys) relative to the use of interactive pedagogies?
2. Do GRS, when used with interactive pedagogies, improve objective indicators of greater student engagement, as measured by verbal class participation (using both counts of participation and average percentage of class participating) relative to the use of interactive pedagogies alone?
3. Do GRS, when used with interactive pedagogies, improve direct learning outcomes (measured by exam performance) relative to the use of interactive pedagogies alone?

RESEARCH DESIGN

This paper reports the results of one study, conducted as part of a larger examination of the effects of GRS in three different accounting courses: accounting information systems, introduction to information technology for accounting students, and introductory management accounting. Since the study was conducted in a similar manner across the three courses, we focus on the introductory management accounting course as an example of the research design and analysis[4]. This approach gives some sense of the generalizability of our findings across different courses. The introductory management accounting course was taught by one instructor in the fall of 2004, with an enrolment of 184 students. All students were enrolled in an accounting co-op honours program, resulting in a relatively homogeneous group in terms of ability. About 70% of the class was female, and ages for the group typically ranged from 20 to 21 years old. The GRS chosen for the study was developed by eInstruction Inc. The response pads resemble a television remote control, and enable students to answer true/false, yes/no, and multiple choice questions with up to five alternative answers.

[4]For the two courses whose results are not discussed, within-subjects analysis of survey results is not possible, and the participation measure is not subdividied into asking versus answering questions. We do get qualitatively similar results for student perceptions of the GRS technology, effects of the GRS on overall perceptions of the course, and effects on objective measures of participation when asking and answering questions are aggregated. For one of the two courses we do not get a significant effect of GRS on exam performance, but for the other course we get a similar effect to what we report here.

Study Procedures

The course had four sections: three had approximately 40 students each and one had 72 students. Figure 1 shows the approach used to deploy the GRS, which involved only two of the sections using the GRS at any time and switching the sections using the system part way through the term. Thus, two sections used the GRS for the first half of the term, while the other two sections used the system for the second half of the term. Each usage period was roughly five weeks in length. Each response pad had a numeric identifier, and was assigned to a particular student for the duration of usage. In keeping with the instructors' plans, students were told that the pads were being evaluated on a trial basis for consideration in future years and in other accounting courses.

<<< Insert Figure 1 About Here >>>

This alternating usage approach facilitated a between-group comparison of performance across GRS and non-GRS sections, since each section was covering the same topics with the same instructor so that differences in these factors should not drive the results from performing comparisons across sections. It also enabled analysis of within-subject changes in behavior corresponding to the GRS and non-GRS periods for each student to be analyzed, since every student used the GRS for some part of the course. Since GRS effects were measured for the first part of the term for one section and the last part of the term for the other section, effects due to maturation or fatigue should affect both GRS and non GRS conditions equally when comparing

GRS effects on a within subjects basis. The five-week duration of use also make it unlikely that novelty effects alone would lead to greater satisfaction with the GRS.[5]

For each class, 4-6 questions were prepared ahead of time by the instructor on aspects of the material the students were to have read about prior to the class[6]. Questions were largely multiple choice, with a few true/false and polling type questions also used. Each class was conducted using an approach modeled after an interactive pedagogy known as peer instruction (Crouch and Mazur 2001). For both the GRS and non-GRS sections, asking the questions using the GRS software was interspersed with computer slide presentations about the topic. The material on the slides was discussed and then a related GRS question asked. For both the GRS and non-GRS sections, the students were encouraged to discuss the question with the students seated next to them before answering. Students were also free to use their textbooks or notes. For the GRS section, students used their response pads to answer the question when ready, with the instructor displaying the histogram of aggregated responses, including the correct response highlighted, when all students had provided a response.[7] For the non-GRS sections the instructor

[5] Our observation of student reactions to the technology indicate that during the first few classes in which it was used, students exhibited more excitement about using the response pads. Once the initial novelty subsided, students seemed to accept use of the GRS as a normal part of the in-class routine.

[6] The number of questions to use for each class session was based on prior studies. Covering too many questions results in a student perception that the technology is being over-emphasized, and once time is allowed for discussion, covering even 4-6 questions in an 80-minute class takes a significant amount of time.

[7] The time allowed for students to enter their responses varied. For the GRS groups, the instructors prompted the remaining students to enter a response when in excess of 80% of students had finished responding. For the non-GRS groups, the instructors determined that the majority of students were ready to answer the question when most of the discussion between students had ended.

asked for a volunteer to answer the question. In the GRS section, if the responses indicated a significant number of students were confused about the correct answer, a student volunteer was asked to explain their response[8], followed by further discussion. In the non-GRS section, if the student volunteer got the answer wrong, the instructor polled additional students until either the right answer was provided or the level of confusion indicated significant student difficulties. The instructor would display the right answer, followed by further discussion.

This approach was used to make the pedagogy between the GRS and non-GRS groups as similar as possible. Both groups had a similar degree of interactivity, and both groups were exposed to the GRS questions. The only difference between the groups was that in the GRS group all students were able to answer the question, and they saw the aggregate section response to that question displayed as a histogram. The "treatment effect", if any, should thus be related to this difference, which is solely related to the technology rather than to differences in underlying pedagogy. Our comparison across sections and within subjects should reflect the effects of the technology incremental to those of using a more interactive pedagogy.

To provide incentives to think about the responses selected with the GRS, 5% of the course mark in each course was based on GRS usage. To promote interactivity and engagement, an additional 5% of the course mark was based on oral class participation (either asking or answering content related questions).

[8] An alternative approach would be to ask all the students to raise their hands and count the number selecting each

Measures of Satisfaction and Learning Outcomes

To collect data on student satisfaction and self-reported effects on learning and in-class behavior, a survey was administered in all courses and sections in the middle of the term immediately after the GRS was switched to the other sections, and at the end of term (see the Appendix for an annotated copy of the survey). Survey questions were modeled on those used in prior studies of GRS to improve comparability as well as to capture multiple dimensions of potential GRS interactivity effects. The survey responses were anonymous to encourage students to answer honestly, with each question answered using a nine point Likert scale centered on zero, with the end points labeled "strongly agree" (4) and "strongly disagree" (-4) and the mid-point (0) labeled "neutral." Students were asked to write a unique identifier known to them but not the instructor on the first page of each of the two surveys to permit a within subjects analysis of the responses to the questions that appeared on each survey.

The average responses to questions specific to student use of the GRS (Questions 10-23) were compared to the scale midpoint of zero to determine student satisfaction with the technology.[9] The average responses to questions generally related to the course, such as whether the course was interesting, etc. (Questions 1-9) were examined using a within subjects analysis

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possible response. However, this was rejected as impractical and time consuming.

[9] Some survey questions (Questions 10, 12, 15, 17, and 22) were stated in negative form to detect students circling the same answer for each question without reading. However, to clarify the presentation and discussion of these items, they have been reverse scored and reported stated in a positive form in the tables and discussion.

to determine if use of GRS had any impact on students' perceptions about these general aspects of the course. The remaining end-of term questions (Questions 24-27) asked students to compare various aspects of the course and their own behavior across the GRS and non-GRS periods and were analyzed in the same manner as the GRS specific questions.

The objective data on in-class participation was collected by a teaching assistant (TA) who attended every class and counted the number of questions asked and answered by each student, as well as whether they were present or absent. To ensure reliability in counting, students were assigned to particular seats, and the TA used a seating chart to track participation by person. Students also used name cards to further reduce the likelihood that their participation would be attributed to someone else.

The participation data was then used to create two standardized participation measures for each student called $Participation_{ask}$ and $Participation_{answer}$[10]. $Participation_{ask}$ is calculated as:

> $Participation_{ask}$ = (average number of questions asked for student *i* per class attended in part *p* of the course – average questions asked for all students for all course sections for part *p*)/ standard deviation of questions asked for all students in the course (i.e., all sections) for part *p*. "*P*" represents the first or second half of the course.

Negative (positive) values of $Participation_{ask}$ indicate lower (higher) average questions asked per class by a particular student than the course average per class for all students in all

[10] This split in the participation measure was done because the number of questions *asked* by students (or course related comments) may be a better reflection of willingness to participate than the number of questions answered.

sections. To determine GRS effects, a difference measure called $DParticipation_{ask}$ was then calculated as $Participation_{askG} - Participation_{askNG}$, where $Participation_{askG}$ ($Participation_{askNG,}$) is the value of $Participation_{ask}$ for the part of the course when the GRS was used (was not used) by a student. If GRS increase participation levels, then $DParticipation_{ask}$ should tend to have positive values, since a given student's participation relative to the class as a whole would be greater than their participation relative to the class when the GRS was not used by the student. The variables $Participation_{answer}$ and $DParticipation_{answer}$ were calculated in the same manner for questions answered orally by students.

The direct measures of GRS learning effects were based on midterm and final examination performance (each of which comprised both multiple choice and written answer questions). Three separate standardized measures of performance were calculated for each student, intended to correspond to performance on exam questions most closely related to the material covered using the GRS (*SPerformance*) [11], performance on all multiple choice exam questions (*MCPerformance*), and performance on the total exam respectively (*TPerformance*). *Sperformance* is most likely to capture a GRS effect on learning, if one exists, since knowledge transfer between questions that are more similar should be easier than transfer between questions that are less similar. Since the GRS was used primarily with multiple-choice questions in each

[11] GRS-related questions included on the mid-terms and final exam were essentially the same as those covered in class with changes made only to the parameter values.

course, we believed there might be a higher correlation between performance on the multiple choice questions and usage of the GRS, which would be captured by *MCPerformance*. *TPerformance* captures the overall effects of the GRS on learning of the course topics. The calculation for *Sperformance* is:

> *SPerformance= (%* correct on GRS related questions for student *i* – average % correct on the same questions for all students in all sections of the course)/standard deviation of the % correct on the same questions for the course.

The measures for *MCPerformance* and *TPerformance* were calculated in a similar way, using the percentage correct of all multiple choice questions and all questions respectively. Analogous to the approach taken with the participation measure to determine GRS effects, difference measures for each of these scores were calculated, called *DSPerformance, DMCPerformance, and DTPerformance* respectively. For example*, DSPerformance* was calculated as *Sperformance* for exam questions where the material was covered with the GRS – *Sperformance* for exam questions where the material was not covered with the GRS.
If use of a GRS improves student learning, then each of these difference measures should tend to have positive values.

It is worth noting that both the participation and learning performance difference measures control for the student's inherent tendency to participate and their ability respectively, since each student's score is based on comparing his or her individual performance with the GRS technology to his or her performance without the GRS technology. Accordingly, no covariate is

needed in the analyses to deal with individual differences in participation or ability.

ANALYSIS

Analysis of Survey Results: Student Self-Reported Effects of GRS

Table 1 shows the averages of the student responses to survey questions concerning the GRS (Questions 10-23). The response rate for the surveys is high (92%), because it was distributed and collected in class. For all questions, the average response was significantly different from 0 in the expected direction at a p-value of .001, indicating student views towards the effects and use of GRS were generally positive.[12] A check for order effects showed no significant differences in the significance or direction of the mean response value for the groups who used the GRS for the first versus second part of the course (not tabulated), with the exception of Question 16, where the response was significantly different from 0 at the .05 level rather than the .001 level for those using the pads for the second part of the course.[13]

<<< Insert Table 1 About Here >>>

The average responses indicate clear agreement with the idea that the GRS (described as

[12] Although the mid-point of the scale (0) was labeled "neutral" not all respondents necessarily interpreted it as such. To provide a more stringent test of students' perceptions of GRS, we also compared the average responses for each question to 1. All comparisons remain significant at a p-value of .01 except for questions 20 and 21 in Table 1 ($p > .50$).

[13] We also compared responses for the Table 1 questions across the four sections of the course. No significant differences were found except for question 16 where the three smaller sections of the course (30-41 students per section) all agreed more strongly that the summarized answer feedback helped them track their progress in the course compared to students in the large section of the course (72 students).

"response pads" in the survey questions) should be used in other courses, as well as with the idea that the response pads were easy to use. The average responses also indicate clear agreement with the idea that the GRS and lectures were effectively integrated, and that the GRS were enjoyable to use. There was also agreement with the idea that the advantages of the GRS outweighed the disadvantages. Overall, the response to these questions are similar to those reported in previous studies in terms of student satisfaction and enjoyment, and there is no indication from the students' perspective of problems in how the GRS was implemented or their use of the technology.

Students' written comments (collected using the survey) on the GRS include the following:

- "Good way to make sure everybody participates, because many are not comfortable. Good to identify problems class is having with subjects or particular ideas."
- "I believe that using the response pads is an ingenious idea and should be used in most courses; especially courses that require reading and are based on comprehension of "concepts" and not so much mathematical operations, etc. It really gives students a chance to gauge their performance on how well they've prepared or understood the topics."
- "My favorite course, even boring material is engaging and fun to learn."
- "Response pads can feel a little intimidating at times, but feel very rewarding when you've answered a question correctly."
- "I think the response pads create a strong incentive for students to stay on track with the course. It is a good method of allocating participation marks. I think it is more fair of an assessment than oral participation since it requires reading ahead of time."
- "I thoroughly enjoyed the response pads. It maintained my interest and encouraged participation and thinking."

There were few negative comments related to the GRS, with those that were provided often related to the stress of having to be prepared for class and to provide the correct answer to the GRS questions. Some sample negative comments included:

- "I believe that the response pad does encourage me to prepare for class. However it also has an effect of discouragement because when I had already tried my best to prepare for the class and still manage to answer the questions wrong, I worry about whether preparing and reading ahead is useful or not."
- "Response pads place a lot of pressure on the class. Made it a lot more stressful. It was also not an appropriate measure of knowledge since people often collaborated or didn't have the time to really think about it."
- "Response pads distracted me from the learning process. It definitely SHOULD NOT be used again next year."
- "Class felt more stressful with response pads because sometimes you don't have time to prepare for class to answer the questions."

Table 2, Panel A shows the average within-subject responses for the GRS versus non-GRS groups for the more general course satisfaction questions (survey questions 1-9)[14]. For five of the nine questions, the students rated various aspects of the course more highly when using the GRS, but only two of these differences were statistically significant, and for the remaining four questions none of the mean differences were significant.

Panels B and C of Table 2 show further analysis of the within-subjects responses to the two questions where there was a main effect of GRS. Panel B shows an order effect for the responses to the question on comfort in participating in class. While the cell means (not

[14] The decline in the number of responses in Table 2 relative to Table 1 stems from some students either not providing a unique identifier, or from changing the value of the unique identifier such that a pair of matching surveys could not be found to do the within-subject analysis.

tabulated) for the students who received the GRS second in the term do not change significantly from about 1.6, the cell means for the students who received the GRS first change from 1.5 with the GRS to 0.9 when the GRS were removed. Panel C also shows a significant order effect for the responses to the question concerning comfort in answering oral questions. The cell means for the group using the GRS first change significantly from 1.3 to 0.4, while the cell means for the group using the GRS second do not change significantly from a value of about 1. These results suggest much of the effect of the GRS on students' self-reported comfort in participation stems from a significant average decline in comfort for those student from whom the GRS were taken away, rather than an increase in comfort from providing the GRS.

<<< Insert Table 2 About Here >>>

A more detailed analysis of the within-subjects results for other order effects in the absence of a main effect (not tabulated) found that for four of the seven questions (course being interesting, comfort asking questions, paying attention in class, and thinking in class) where there was no main effect of the GRS, there was a significant change in the average response for students using the GRS first. In these four cases, the average response of the group using the GRS first tended to be higher than or comparable to the non-GRS using group for the same period in time, and then declined sharply when the GRS were taken away.

Similarly, for three of the seven questions (course well organized, comfort asking questions, and thinking in class), where there was no main effect of the GRS, there was a

significant change in the average response for the students using the GRS second. For both comfort asking questions and thinking in class, students' average response declined when the GRS were used, relative to the period when the GRS were not used, with the non-GRS values for the students using the GRS second being comparable to the GRS values of those using the GRS first[15].

In summary, the self-reported effects of the GRS on more general perceptions of the course are somewhat mixed. To the extent significant differences exist, they tend to be related to sharp declines in student ratings for the group who had the GRS first when the GRS was taken away, and to a lesser extent to declines in ratings for the group who had the GRS second when the GRS were introduced. Given the lack of significant differences between the two groups in perceptions about the GRS itself, these differences in more general course perceptions do not appear to be related to differences in how the GRS were implemented or used.

Table 3 shows the responses to the end of term questions that asked the students to directly compare their understanding, course enjoyment, and comfort in participating for the part

[15] Further analysis of the responses to the survey questions concerning comfort asking questions and thinking in class for the students using the GRS second was performed to see if there was a difference between the large and small section. We found that the decline in response to the "thinking in class" question when the GRS were used was largely associated with the large section, and that there was no difference in the average responses for this questions for the small section when comparing the GRS to non-GRS usage responses. However, the decline in the average response for the "comfort asking questions" occurred for both the large and small section when the GRS were used. We thus can not conclude that the decline when GRS is used is only associated with the large section.

of the course that used the GRS to the part of the course that did not use the GRS (questions 24-27 on the survey). While the responses for understanding and enjoyment are significantly different from 0 (in the expected direction) with a p-value of less than .001 for both questions, the responses regarding comfort in answering or asking questions are not significantly different from 0.[16]

<<< Insert Table 3 About Here >>>

When the survey results are considered as a whole, the responses concerning participation effects of the GRS are somewhat contradictory. Overall the results in Table 1 suggest students enjoyed the GRS, felt it improved learning, and noticed no implementation problems. However, while students indicated that they felt more comfortable participating when the response pads were used (Table 1, Question 14), they did not on average feel it improved oral participation relative to the part of the course where the GRS was not used (Table 3). The within subjects analysis (Table 2) suggests that use of the GRS decreased comfort in asking questions for the group using the GRS second, and generally resulted in less comfort orally participating when taken away from the group that used the GRS first. It could be that the initial survey question asking whether the GRS made the student feel more comfortable participating in class was interpreted as meaning "participating with the response pad", while the other participation

[16]We found no significant differences in the responses to these questions between students who used the GRS during the first half of the course and those who used the GRS during the second half of the course. Similarly, we found no differences in responses across the four sections of the course.

questions specifically refer to asking questions and answering oral questions, which the students did not feel were affected by GRS usage. Alternatively, the placement of the participation question among the other GRS specific questions may have created a "halo effect", which led to a positive response for this question but not for the other questions that were not as proximate to the GRS specific questions. Another possibility is that students become less comfortable with conventional participation means after they have used the GRS technology.

Where comparable, our results from the student surveys are similar to those reported by prior studies. For example, 84% of the students in our study felt the advantages of the response pads outweighed the disadvantages, compared to 80% reported by Draper and Brown (2004). In our study, 74% of students claimed the course was more enjoyable when response pads were used, versus 90% of students reported in Abrahamson (1999) as claiming the course was more enjoyable. Our use of a control group enables us to do more precise measures of GRS effects on general course perception than the previous studies, which did not employ a control group. Thus, although students on average report the course as interesting, well organized, and with effective presentation of material, we do not find evidence suggesting significant improvements in general perceptions of the course for GRS users relative to non-GRS users. Our results suggest that when an interactive pedagogy is used, GRS have limited impact on incrementally improving general perceptions of the course, even when students indicate satisfaction with the technology itself.

Analysis of GRS Effects on Objective Measures of Participation

Table 4 Panel A reports the cell means for the objective participation measure $DParticipation_{ask}$. As noted earlier, if the GRS increase average participation levels per student, then $DParticipation_{ask}$ should tend to be positive and significantly different from 0. Panel A shows that the impact of the GRS are opposite to what we expected. The mean of $DParticipation_{ask}$ for students who used the GRS in the first part of the course is -.16, and -.10 for those that used it in the second part, with both results significantly different from 0 at the .05 level. This indicates students asked more questions when the GRS was *not* in use.

To further refine the analysis, we performed an ANOVA and included a control variable for order effects and another control variable based on each student's assignment to a participation quartile (reflecting overall participation in the course). This latter variable was included to determine if the GRS had differential effects on the behavior of students who tended to participate a lot versus those who participated little. Panel B shows no significant order effects, but there was a significant effect of the participation quartile. Inspection of the cell means for the participation variable by participation quartile (not tabulated) show that students who asked the most questions relative to the group had the greatest reduction in asking questions when the GRS was used, with relatively little effect of the GRS on the other three quartiles.

<<< Insert Table 4 About Here >>>

Panel C of Table 4 shows the analysis of the effects of the GRS on students answering questions. There was no significant differences among the cell means for $Dparticipation_{answer}$ for those students using the GRS versus not using the GRS (not tabulated). Panel C indicates that there were also no order or participation quartile effects on this measure of participation. Answering questions may be less affected than asking questions, since the instructor typically will wait for a question to be answered, whereas students can elect not to ask a question at all.

Table 5 provides further evidence on the effects of GRS, by examining its effects on the average percentage of students asking questions in each class period over the term. The number of questions asked by the professor is used as a covariate to control for the possibility that more active questioning by the professor may generate questions from students. A control for order effects was also included in the ANOVA. Consistent with the results reported in Table 4, (Panels A and B) the analysis in Table 5 shows a significant effect of the GRS on the percentage of students asking questions in each class ($p < .05$), with a comparison of means (not tabulated) showing that a smaller percentage of the class asked questions when the GRS was used compared to when it was not (7.6 % versus 10.0%). There were no order effects, nor any interaction between order and GRS usage. An equivalent analysis (not tabulated) of the percentage of students orally answering questions in each class showed no effects of the GRS[17].

[17] The counts of the number of questions answered by students excluded answers of the questions displayed using the GRS in the control groups to avoid biasing the measure.

<<< Insert Table 5 About Here >>>

A possible reason for the GRS apparently decreasing students' willingness to ask questions in class may be related to the difficulty of the multiple choice questions used with the GRS. The average percentage correct for all GRS questions was 84%, which means that the histograms displayed after each GRS question was completed showed that the majority of the class had responded correctly. A possible implication of this is that students are less likely to ask questions when GRS results show that a large majority of the class understands the concept being discussed. Conversely, no such feedback is available in the non-GRS sections so there is more uncertainty (among the students) about the extent to which a concept is understood. To evaluate this possibility, a correlation was calculated between the percentage of students asking a question in each class where the GRS was used and the overall score for that class on the GRS multiple choice questions. The correlation coefficient is negative (-.28) and significant ($p < .10$) indicating the more difficult the GRS questions, the greater the percentage of students asking questions. Thus it appears that a GRS can actually stifle discussion in classes where the feedback from the system indicates the majority of students understand the concepts being reviewed.

Analysis of GRS Effects on Direct Measures of Learning

The final analysis was to determine the effects of the GRS on the three direct measures of learning outcomes. Table 6 shows the results of the analysis of variance performed on the

standardized difference scores for each of the three measures. As noted earlier, values for these variables should be positive and significantly different from 0 if GRS improves the aspects of learning captured by our measures.

<<< Insert Table 6 About Here >>>

Panel A shows the cell means for each combination of measure and time period the GRS was used (the first or second part of the term). The only significant result is the impact of GRS on performance for the multiple choice questions closely related to those displayed with the GRS during class (*DSPerformance)*. For this measure, the scores are positive and significantly different from zero at the .05 and .10 levels for the groups that used the GRS for the first and second part of the term respectively. This provides some evidence that use of the GRS significantly improved performance on the GRS-related multiple choice exam questions. Panel B shows no significant order effect. Examination of the raw means for the multiple choice questions (not tabulated) shows that the size of the learning effect was an improvement of about four percentage points for students using the GRS relative to the class average for the same subset of questions.

The results for Panels A, C and D show that GRS did not have a significant effect when performance was measured using either all multiple choice questions on the exam or the entire exam score (p-values of .481 and .349 respectively). Panel A shows that the GRS effects are in the expected direction for both measures, but do not differ significantly from 0. Panels C and D

indicate that there were no order effects for either of these measures. Thus, the impact of the GRS appears to be limited to performance on questions very similar in nature to those employed when using the system. However, since all students (GRS and non-GRS users) saw the questions, the differential effects of the technology would appear to be associated with some characteristic of GRS, rather than greater familiarity by the GRS users with the GRS related questions.

CONCLUSIONS AND LIMITATIONS

A review of vendor websites (e.g., those of eInstruction and GTCO CalComp) suggests GRS are becoming a popular tool with educators generally, with accounting educator interest evidenced by papers at the AA and the availability of accounting textbooks bundled with the technolog. However, the results of our research suggest the possible need to temper some of the enthusiastic claims concerning the effects of GRS on learning and engagement.

Contrary to the claims of proponents, we do not find objective evidence of heightened student engagement as measured by verbal participation, but rather some evidence that in some circumstances GRS can reduce the asking of questions by students. While we do find evidence of positive learning outcomes associated with GRS, the effects are small and limited to those questions most directly related to those displayed by the GRS. We believe our results highlight the need for further research to determine if and how GRS can affect learning outcomes. It should be noted however, that our research design required GRS to demonstrate learning effects

incremental to an interactive pedagogy, and thus created a fairly significant hurdle for GRS to overcome. Nonetheless, we feel this is an appropriate comparison, as the learning benefits of interactive pedagogies should not be confounded with those of GRS, particularly given the costs involved in acquiring and using GRS.

Our study provides evidence that replicates previous findings and extends the literature on the effects of GRS on direct and indirect learning outcomes. Consistent with prior research, average student responses to our survey questions suggest strong student satisfaction with the technology. This finding reduces the possibility that any non-significant results on our more objective measures of student engagement and learning arose from a poor implementation of the system.

Our extension of prior research to include a control group resulted in a finding of no significant change in student views of most aspects of the course when using versus not using the GRS. In those cases where student perceptions did change, it often seemed related to a decline in ratings when the technology was taken away, rather than an improved perception from providing the technology. In particular, the within subjects finding that students reported being significantly less comfortable participating and less comfortable answering questions once they have had the GRS and it has been removed requires further research. It could be that the GRS creates a comfortable participation environment for students that they are most aware of when it is gone. The decline in the average number of questions asked and the lower percentage of

students asking questions in the groups using the GRS relative to those not using GRS supports the within-subjects analysis findings, and is contrary to what would be expected if GRS does heighten student engagement. Further research is needed to explore our finding regarding the relationship between GRS question difficulty and asking questions as one possible factor in GRS's effect on class participation. We also had a surprising finding that for some course related aspects, ratings declined when the GRS was used, particularly when this use occurred in the second part of the course. We have no explanation for this latter effect, and it could be a spurious result. Overall, we conclude that student reports of enjoyment of the GRS technology do not necessarily mean a course is generally regarded more favorably across any of several dimensions or that participation is improved when the effects of increased interactivity associated with changes in pedagogy are held constant.

Our study is the first that we are aware of to examine whether a GRS has any effect on learning outcomes, incremental to an interactive pedagogy. We do find modest evidence of improved learning for those questions most related to those covered with the GRS. Whether removal of the 5% mark incentive for answering GRS questions (which presumably encourages effort) would reduce the exam performance effects found is unknown.

Finally, differences in pedagogy is the other factor that should be explored in determining the effects of GRS. Despite our efforts, it is possible that the pedagogical approach we used was not interactive enough, or some other pedagogical characteristic would be more important in

enabling a GRS effect. Further research is needed to investigate all of these factors before arriving at definitive conclusions on the effects of GRS on student satisfaction and learning in accounting education.

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Figure 1
Timeline for GRS Deployment

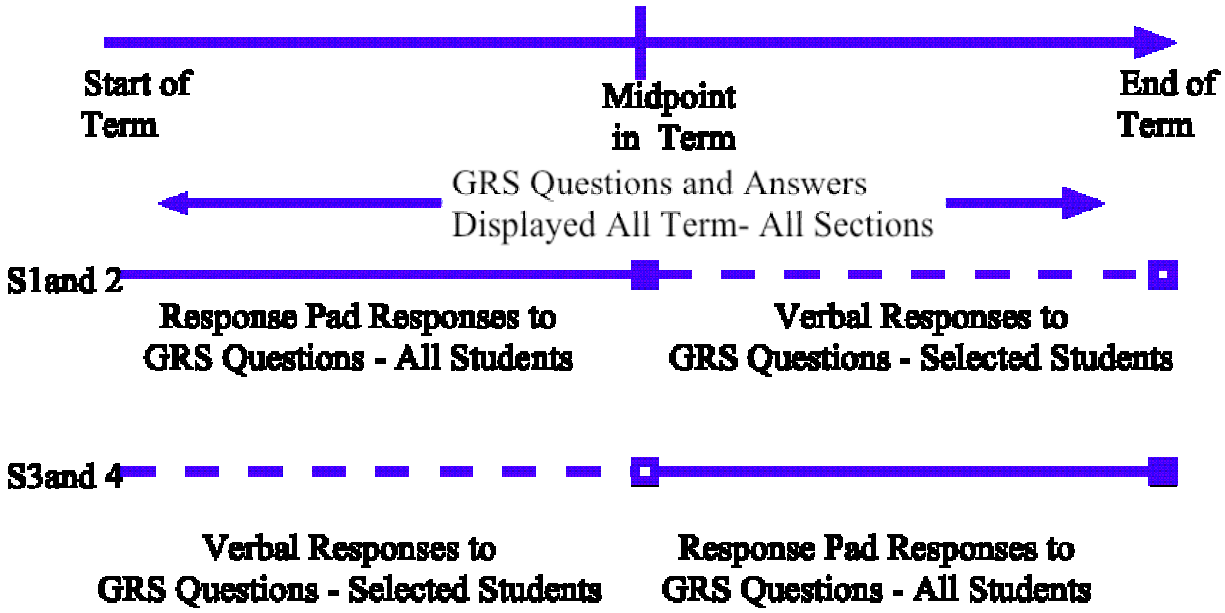


Table 1
Survey Response Means for GRS Specific Questions

Survey Question	Number of Responses	Response Means
10. Course does not focus too much on using response pads	172	1.959****
11. Lecture and response pads effectively integrated	172	2.358****
12. Response pads are easy to use	172	3.294****
13. Enough time to answer questions using response pads	171	1.658****
14. More comfortable participating when response pads used	170	2.038****
15. Response pads help learn material	171	1.751****
16. Summarized class answers help track progress	171	1.535****
17. Confident that response pads accurately record responses	171	1.912****
18. Enjoy using response pads	171	2.351****
19. Instructor clarifies correct solution for response pad questions	171	2.953****
20. Response pads encourage working harder to answer questions	172	1.250****
21. Response pads encourage working harder to prepare for class	171	0.825****
22. Response pads should be used in other courses	170	1.988****
23. Advantages of response pads outweigh disadvantages	170	2.250****

****, ***, **, and * refer to a significant difference from 0 at the .001, .01, .05, and .10 levels respectively, one tailed.

Table 2
Within Subjects Analysis of General Course Questions

Panel A: Descriptive Statistics

Survey Question	Number of responses: GRS	GRS in Use	Std. Deviation	GRS Not in Use	Std. Deviation
1. Course interesting[1]	128	1.969	1.418	1.867	1.195
2. Comfortable participating[1,2]	128	1.594	1.647	1.301	1.650
3. Course well organized[1]	128	2.297	1.544	2.328	1.351
4. Material presented effectively	128	1.891	1.612	1.832	1.358
5. Feel comfortable asking questions[1,3]	128	0.914	1.942	1.098	1.660
6. Classes help master course material	128	1.219	1.900	1.313	1.627
7. Easy to pay attention in class[1,3]	128	0.910	1.969	0.867	1.813
8. Comfortable answering oral questions[1,2]	128	1.133	1.758	0.805	1.848
9. Required to think in class about course concepts[1,3]	128	2.117	1.436	2.020	1.502

[1] Significant ($p < 0.10$ or lower) interaction between order (treatment first vs. second) and within subjects measure.

[2] Significant ($p < 0.10$ or lower) within subjects difference: GRS in use vs. GRS not in use.

[3] Question was stated in the negative form on the survey

[4] GRS: the within subjects factor measured twice, GRS in use and GRS not in use.

[5] Order: indicator of whether the student used the GRS during the first or second half of the course.

Table 2 (continued)

Panel B: Within Subjects Measure "Comfortable Participating"; n = 128					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**p**
GRS[1]	7.564	1	7.564	5.205	.024
Order[2] x GRS	5.025	1	5.025	3.458	.065
Error	183.107	126	1.453		

Panel C: Within Subjects Measure "Comfortable Answering Oral Questions"; n = 128					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**p**
GRS	11.083	1	11.083	9.209	.003
GRS First x Order	13.958	1	13.958	11.597	.001
Error	151.651	126	1.204		

[1]GRS: the within subjects factor measured twice, GRS in use and GRS not in use.

[2]Order: indicator of whether the student used the GRS during the first or second half of the course.

Table 3
Survey Response Means for End of Term Comparative Questions Comparing the GRS to the non-GRS Portions of the Course

Survey Question	Number of Responses	Response Means
24. Compared to the part of the course that did not use the response pads, I had a better understanding of material when response pads used	161	0.689****
25. Compared to the part of the course that did not use the response pads, the course was more enjoyable when response pads used	161	1.720****
26. Compared to the part of the course that did not use the response pads, I felt more comfortable asking questions when response pads used	161	-0.037
27. Compared to the part of the course that did not use the response pads, I felt more comfortable answering oral questions when response pads used	161	0.090

****, ***, **, and * refer to a significant difference from 0 at the .001, .01, .05, and .10 levels respectively, one tailed.

Table 4
Analysis of the Effects of GRS on Standardized zScores Based on Average Oral Participation Per Student Per Class

Panel A: Cell Means for $DParticipation_{ask}$ [1]

Cell	N	Mean	Standard Deviation
GRS First	73	.158**	.59
GRS Second	113	.102**	.60
Overall	186	.124**	.59

Panel B: Between Subject Results with a Control for Level of Participation (N=186) and $DParticipation_{ask}$ as the Dependent Variable:

Source	Type III Sum of Squares	df	Mean Square	F	p
Order[2]	.004	1	.004	.133	.716
Participation Quartile[3]	4.196	1	4.196	12.713	.001
Order x Quartile	.117	1	.117	.354	.552
Error	140.135	182	.820		

Panel C: Between Subject Results with a Control for Level of Participation (N=186) and $Dparticipation_{answer}$ as the Dependent Variable: [4]

Source	Type III Sum of Squares	df	Mean Square	F	p
Order[2]	.002	1	.002	.083	.773
Participation Quartile[3]	.123	1	.123	.378	.540
Order x Quartile	.002	1	.002	.085	.771
Error	59.368	182	.326		

** refers to a significant difference from 0 at the .05 level, one tailed.

[1] $DParticipation_{ask}$: calculated by taking the difference between the z-scores of the average number of questions asked per class per student when the GRS was used and the z-scores of the average number of questions asked per class per student when the GRS was not used.
[2] *Order*: a dummy variable indicating the portion of the course (first half or second half) the GRS was used.
[3] *Participation quartile*: Students were assigned to quartiles based on their overall level of course participation.
[4] $DParticipation_{answer}$: calculated by taking the difference between the z-scores of the average number of questions orally answered per class per student when the GRS was used and the z-scores of the average number of questions orally answered per class per student when the GRS was not used.

Table 5

Analysis of the Effects of GRS on the Percentage of Students Participating in Class

Between Subject Results with a Control for Number of Questions asked by Professor (N=88) and *Percent*$_{ask}$ as the dependent variable:[1]

Source	Type III Sum of Squares	df	Mean Square	F	p
GRS[2]	120.46	1	120.46	5.207	.025
Order[3]	.873	1	.873	.038	.846
GRS x Order	8.741	1	8.741	.378	.540
Questions[4]	6.604	1	6.604	.285	.595
Error	1920.206	83	23.135		

[1]*Percent*$_{ask}$: the percentage of students asking a question in each class. A separate observation for each section is included in the analysis (4 sections x 22 classes = 88 independent observations).

[2]GRS: a dummy variable indicating whether or not the GRS was in use for the class.

[3]Order: a dummy variable indicating for each section whether the GRS was used during the first or second half of the course.

[4]Questions: the number of questions asked by the professor during each class for each section.

Table 6
Analysis of the Effects of GRS on Standardized zScores Based on Exam Performance

Panel A: Cell Means for the Three Measures of Learning

Measure and Cell	N	Mean	Standard Deviation
DSPerformance[1]			
GRS First	73	.240**	1.05
GRS Second	113	.155*	1.13
DMCPerformance[2]			
GRS First	72	.064	.907
GRS Second	111	.050	1.16
DTPerformance[3]			
GRS First	73	.049	1.00
GRS Second	111	.073	.758

Panel B: Between Subject Results with *DSPerformance* as the Dependent Variable (N=186):

Source	Type III Sum of Squares	df	Mean Square	F	p
Order[4]	.320	1	.320	.266	.607
Error	221.413	184	1.203		

Panel C: Between Subject Results with *DMCPerformance* as the Dependent Variable (N=186):

Source	Type III Sum of Squares	df	Mean Square	F	p
Order	.001	1	.001	.007	.933
Error	206.141	184	1.139		

Table 6 (Continued)

Panel D: Between Subject Results with *DTPerformance* as the Dependent Variable (N=186):

Source	Type III Sum of Squares	df	Mean Square	F	p
Order	.002	1	.002	.034	.855
Error	135.629	184	.745		

** and * refer to a significant difference from 0 at the .05 and .10 levels respectively, one tailed.

[1]*DSPerformance*: the difference between the z-scores of the students' performance (%) on GRS-related exam multiple choice questions when the GRS was used and the z-scores of students' performance (%) on GRS-related exam multiple choice questions when the GRS was not used. Note that the same multiple choice questions were used for each section whether or not the GRS was in use.

[2]*DMCPerformance*: the difference between the z-scores of the students' performance (%) on all multiple choice exam questions when the GRS was used and the z-scores of students' performance (%) on all multiple choice exam questions when the GRS was not used.

[3]*DTPerformance*: the difference between the z-scores of the students' performance (%) on all exam questions when the GRS was used and the z-scores of students' performance (%) on all exam questions when the GRS was not used. The slight reduction in the sample size from the total class enrolment is due to students who missed the midterm exam, and thus could not have a difference score calculated for them.

[4]Order: a dummy variable indicating for each section whether the GRS was used during the first or second half of the course.

APPENDIX
Example Survey Used to Collect Student Satisfaction and Subjective Measures of Learning Effects

Note: Questions 1-9 were asked of all sections in both the middle and end of term survey. Questions 10-23 were asked only of these sections that had just completed using the GRS. Questions 24-27 were asked of all sections at the end of the term.

Please respond to <u>each</u> of the following questions by placing an x on the scale, wherever you feel appropriate. Please do <u>not</u> put your name on this document. This information will be compiled and given to the instructor, but all responses will be anonymous. This survey is not a substitute for the normal end of term course evaluation.

1. I find this course interesting.

-4	-3	-2	-1	0	1	2	3	4
strongly disagree		disagree		neutral		agree		strongly agree

2. I feel comfortable participating in this course.

-4	-3	-2	-1	0	1	2	3	4
strongly disagree		disagree		neutral		agree		strongly agree

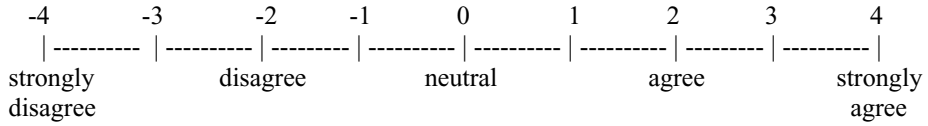
3. This course is <u>not</u> well organized.

-4	-3	-2	-1	0	1	2	3	4
strongly disagree		disagree		neutral		agree		strongly agree

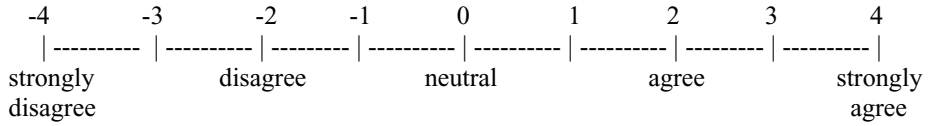
4. The course material is presented effectively.

-4	-3	-2	-1	0	1	2	3	4
strongly disagree		disagree		neutral		agree		strongly agree

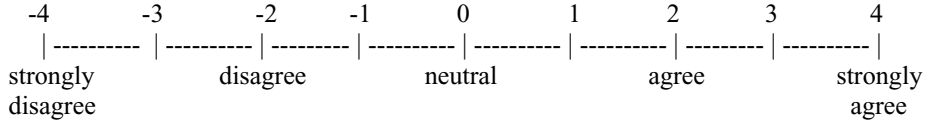
5. I do not feel comfortable asking questions in this course.



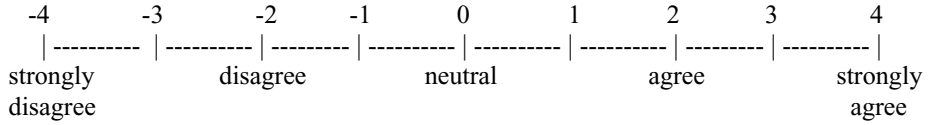
6. The classes help me master the course material.



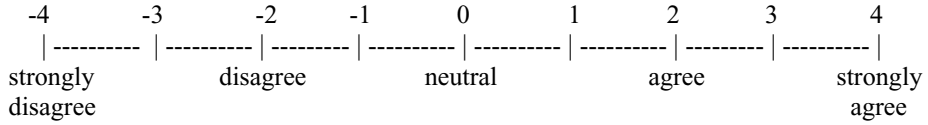
7. I have trouble paying attention in class.



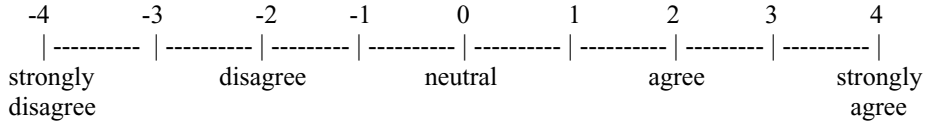
8. I feel comfortable answering oral questions in this course.



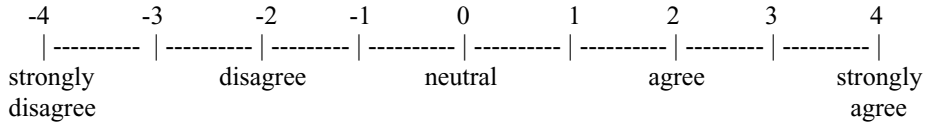
9. I am not required to think much in class about course concepts.



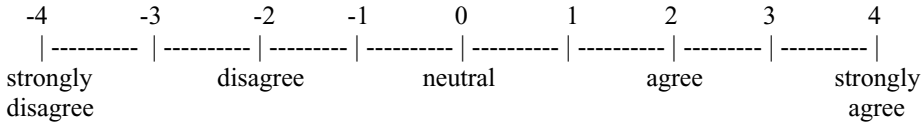
10. This course focuses too much on using the response pads.



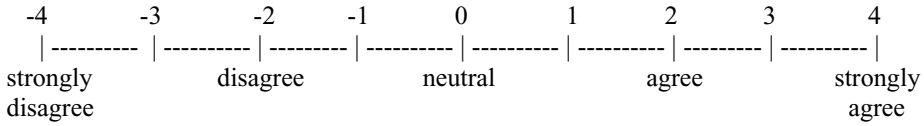
11. The lecture and response pad usage are effectively integrated.



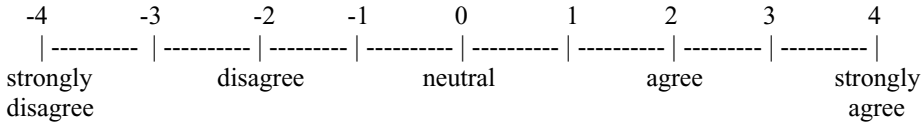
12. The response pads are <u>not</u> easy to use.



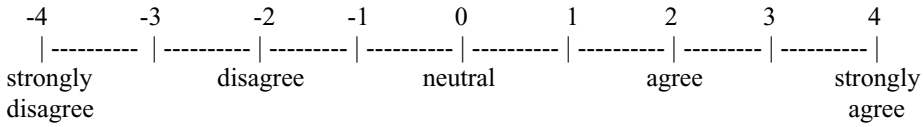
13. I have enough time to answer the questions with the response pads.



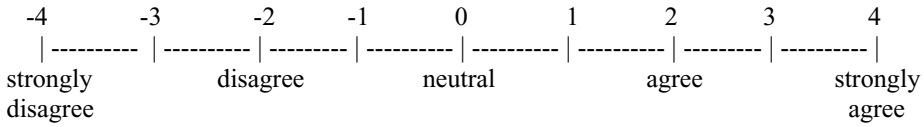
14. The response pads make me feel more comfortable participating in the course.



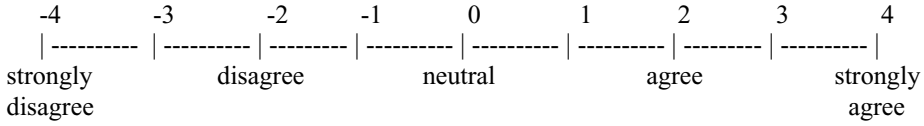
15. Using the response pads does <u>not</u> help me learn the material in this course.



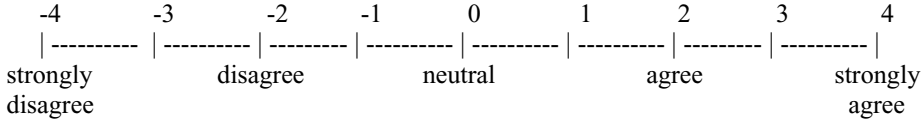
16. Seeing the summarized class answers to response pad questions helps me track my progress in the course.



17. I am <u>not</u> confident that the response pads accurately record my responses.



18. I enjoy using the response pads to answer questions in this course.



19. The instructor clarifies and explains the correct solution for questions answered with the response pads when a significant number of students have difficulty determining the correct answer.

-4	-3	-2	-1	0	1	2	3	4
strongly disagree				neutral				strongly agree

20. Knowing the response pads will be used encourages me to work harder <u>to answer questions</u> in class.

-4	-3	-2	-1	0	1	2	3	4
strongly disagree				neutral				strongly agree

21. Knowing the response pads will be used encourages me to work harder <u>to prepare</u> for class.

-4	-3	-2	-1	0	1	2	3	4
strongly disagree				neutral				strongly agree

22. The response pads should <u>not</u> be used in other courses.

-4	-3	-2	-1	0	1	2	3	4
strongly disagree				neutral				strongly agree

23. Overall, the advantages of using the response pads outweigh the disadvantages in this course.

-4	-3	-2	-1	0	1	2	3	4
strongly disagree				neutral				strongly agree

24. Compared to the material in the part of the course that did <u>not</u> use the response pads, I have a better understanding of the material in this course when the response pads were used.

-4	-3	-2	-1	0	1	2	3	4
strongly disagree				neutral				strongly agree

25. Compared to the part of the course that did <u>not</u> use the response pads, the part of this course that used the response pads was more enjoyable.

-4	-3	-2	-1	0	1	2	3	4
strongly disagree				neutral				strongly agree

26. Compared to the part of the course that did <u>not</u> use the response pads, I felt more comfortable <u>asking</u> questions in the part of the course that did use the response pads.

-4	-3	-2	-1	0	1	2	3	4
strongly disagree		disagree		neutral		agree		strongly agree

27. Compared to the part of the course that did <u>not</u> use the response pads, I felt more comfortable <u>answering</u> <u>oral</u> questions in the part of the course that did use the response pads.

-4	-3	-2	-1	0	1	2	3	4
strongly disagree		disagree		neutral		agree		strongly agree

<u>Any other comments?</u>