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The Interaction of Pedagogical Approach, Gender, Self-Regulation, and Goal Orientation Using Student Response System Technology

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Abstract

This research compares a behaviorally based approach for using electronic student response system (SRS) technology with a metacognitive-oriented approach to determine effects on attendance, preparation for class, and achievement. Also examined are the interaction effects of pedagogical approach with self-regulatory and motivational characteristics of students. MANOVA analyses of pretest, posttest, attitudinal, and attendance data revealed no significant difference between approaches on achievement. A main effect was found for self-regulation level and achievement, as well as for goal orientation and class preparation/attendance. Other findings are that students in the operant conditioning group were significantly more likely to be anxious when using SRS but were more motivated to prepare for and attend class than the metacognitive group. Finally, type of pedagogy and self-regulation level also interacted significantly on the achievement measure, with highly self-regulated students in the metacognitive group outperforming students with low self-regulatory skills. (Keywords: student response systems, effective pedagogy, behaviorism, metacognition, self-regulation, goal orientation.)

INTRODUCTION

Since the introduction of the personal computer in the late 1970s and the subsequent emergence of a host of technological tools and gadgets, questions have been raised about technology's influence on students' learning and academic achievement. After 25 years of research, a consistent finding is that technology is not the panacea for dramatically increasing standardized test scores. "The amount of technology available to assist teachers is staggering, and it's way ahead of teacher knowledge" (Trotter, cited in Levin-Epstein, 2000, p. 1). Teachers at all educational levels, even those who use a computer for many tasks, still remain fundamentally uncertain about how to use technology to solve real, everyday classroom problems (Coppola, 2004). Levin-Epstein (2000) comments, "It's no longer a question of teaching teachers how to use technology; it's about teaching them when and why to use it" (p. 1).

As early as 1986 (Apple, 1995), however, researchers reported changes in the behavior of teachers and students, noting that students were taking more responsibility for their own learning, and teachers were working more as mentors and less as presenters of information. New and innovative technologies and the related pedagogy that potentially can transform traditional classrooms to more learner-, knowledge-, and assessment-centered contexts should be examined

empirically (National Research Council, 1999). Indeed, converging evidence supports a relationship between effective pedagogy and technology and multiple desirable outcomes, including students' adoption of learning or mastery (intrinsic) goals (Roschelle, Penuel, & Abramhamson, 2004) and conceptual change and achievement, particularly in physics (Burnstein & Lederman, 2001; Hake, 1998).

Interactive electronic response systems, also termed student or personal response systems, classroom or audience response systems, or simply "clickers," are a software/hardware technology increasingly used in K–12 and higher education. For example, Classroom Performance System (CPS), only one of numerous response systems now available to educators, has more than 3 million response pads in all 50 states in thousands of K–12 schools as well as more than 800 universities and 10 foreign countries. The technology also is utilized for training in corporate and military settings (e-Instruction, 2006). These remote control devices allow the instructor to get instant feedback easily from students via a portable receiver. Students are shown a question and they respond by pressing one of eight buttons on their remote control. Responses are tallied by computer and feedback is available in the form of histograms and detailed reports that are presented on the computer screen. The technology is utilized in a variety of ways: for taking attendance, giving informal and formal quizzes, polling student opinions, reviewing for formal assessments, providing spontaneous feedback, and promoting team-building among students in large classes.

A body of research on the practical and technical issues related to implementation and comparison of the many marketed systems has rapidly grown (Burnstein & Lederman, 2003). Students self-report that they enjoy using SRS and indicate that they are more attentive in class and better understand course concepts (Byrd, Coleman, & Werneth, 2004; Judson & Sawada, 2002). Recommendations for ways the technology can be used interactively have been based on survey data and anecdotal evidence (Purchase, Mitchell, & Ounis, 2004). Gains in learning outcomes in classes using SRS have been reported with end-of-course exam or standardized achievement test as the outcome measure. Few of these studies, however, used a comparison group, and none placed statistical controls on the comparison group (Roschelle, Penuel, & Abrahamson, 2004).

In a 2006 review of the literature of research on student response systems, Fies and Marshall report that SRS research generally has compared non-SRS traditional teaching practice with use of SRS. For example, a study from the Netherlands by Poulis, Massen, Robens, and Gilbert (1998) reported data from more than 5,000 students who took either traditional lecture courses in physics or courses that used a response system. The data were collected over four years; during that time, some instructors taught for two years without the response system followed by two years with it, and another group of instructors first taught with the response system and later stopped using it. The content of the courses and the exam were monitored by the investigators to make sure they did not change from year to year. The end-of-course exam pass rate was used as an outcome measure. Findings indicated a significantly higher passing score mean in classes using the response system as well as a smaller variance in scores.

In another study, Hake (1998) surveyed 6,000 students in both university and high school settings and compared traditional lecture courses with interactive engagement courses. Interactive engagement courses promoted conceptual understanding through the use of technology providing immediate feedback to both the students and the instructors. The investigator found 30% to 70% gains in the interactive engagement courses; whereas, gains below 30% were found in the traditional courses.

According to Fies and Marshall (2006), SRS research that has focused on pedagogical theory has investigated specific issues such as timing of feedback. Broader topics, such as the affordances of instantaneous feedback aggregation on small group interactions and whole-class evaluations, also have been examined. For example, research on SRS used in conjunction with Mazur's Peer Instruction (PI) model (1997) found that SRS improved student engagement and learning outcomes. Other research has found that the effectiveness of the PI feedback model is independent of the use of technology or SRS, however. Another instructional sequence, based on Kolb's experiential Learning Cycle (Dufresne, Gerace, Leonard, & Mestre, 2000), promotes a conceptually based problem-solving context in which "discussion follows a spiraling pathway" (Fies & Marshall, 2006, p. 104). In this context, a question leads to exploration of another question and another question, such that the class directs which questions are asked and discussed

Overall, however, after their SRS literature review, Fies and Marshall (2006) found that "There is insufficient research on what constitutes optimal conditions of [SRS] use" (p. 101). They further note that, in general, extant research has focused on individual rather than group use of SRSs and seldom depicts how it is used for formative assessment. Empirical evidence on the influence of particular pedagogical uses of the technology system on achievement thus is limited. Moreover, the interaction effects of other variables, such as student self-regulation and goal orientation with different types of pedagogical approach, are not known.

To address questions related to SRS pedagogy and student characteristics, this quasi-experimental research study investigated two pedagogical/instructional uses of SRS (CPS, e-instruction) in two sections of an undergraduate introductory course. Each section had 60 participating students. The objective of the study was to examine student-related behaviors, such as attendance and preparation for class and achievement associated with two instructional approaches. In addition, the relationships among students' self-regulatory and motivational characteristics, instructional approach, and achievement were investigated.

The research study is framed around the following research questions:

1. Does the instructional approach of SRS use (operant conditioning vs. metacognitive) differentially influence student achievement?
2. Does instructional approach interact with individual differences, specifically, gender, level of self-regulation, and goal orientation?
3. Are other student outcomes (level of anxiety, class preparation and attendance) influenced by the instructional approach of SRS use?

The research hypotheses stated below derive from the research questions posed above.

H1: The metacognitive approach will influence student achievement to a greater extent than the operant conditioning approach.

H2: Instructional approach of SRS use will interact with self-regulation and goal orientation on achievement.

H3: Level of anxiety, attendance, and preparation for class will be influenced differentially by approach of SRS use.

BEHAVIORISM OR METACOGNITION: IS ONE A BETTER FIT?

Behaviorism: The Operant Conditioning Perspective

Although touted as an emerging and innovative technology, Judson and Sawada report that SRSs "cannot be considered emerging technology" (2002, p. 176), for even in the 1960s, instructors in some college lecture halls were able to ask questions, and students could give informative electronic feedback. The behavioral perspective was prevalent during these decades, with a Skinnerian theoretical framework providing the basis for immediate feedback as to the correctness of an answer. Research from the 1960s and 1970s, however, did not find a significant correlation between student academic achievement and a stimulus-response method of using such systems.

More recently, as educators have sought ways to engage students actively, particularly in larger classes SRS has been viewed as a viable tool. Inattentive behaviors, even nodding off, are more prevalent in large lecture classes (Appleby, 1990) because of the greater anonymity than in smaller classes, and SRS features appear to hold students accountable for classroom participation. When viewed through an operant conditioning lens, attentive and engaged behaviors may be influenced by innovative SRS technology. These newer technology systems enable the display of appealing graphic representations of student responses. This additional immediate and particularly salient feedback not present in the 1960s behavioral research, may influence student achievement, a finding that would contradict the 1960s research. The operant conditioning perspective suggests that immediate, graphically rendered and visually pleasing feedback may serve as positive reinforcement. Moreover, students may increase their study behavior because of the positive reinforcement of getting 'a good grade.' Another type of reinforcement also may come into play, however. By definition, reinforcement is "a stimulus [the addition] or reduction or removal of which strengthens behavior" (Skinner, 1989, p. 127, cited in Gredler, 2005). If the behaviors of reading text assignments, attending and paying attention in class increases because an aversive stimulus is removed or reduced (e.g., fear of doing poorly on the quiz, looking dumb in class, or nagging of parents about grades), the type of reinforcement is negative. The type of reinforcement that may occur within the operant conditioning approach to using SRS may, therefore, be either positive or negative, depending on the response of the particular student.

Cognitive Information Processing: The Metacognitive Perspective

A paradigmatic shift from behaviorism to cognitive information processing occurred in the mid 1960s, and individuals' cognitions, rather than envi-

ronmental variables, were used to explain behavior. The second pedagogical approach of this study focuses on the idea of developing students' metacognition—i.e., the deliberate and conscious control of cognitive activity (Flavell, 1985). From the information processing perspective, metacognition is the executive control function that enables self-monitoring and self-assessing of thoughts and learning. Essentially, metacognition means thinking about thinking (Garner, 1987). Through a metacognitive lens, the instantaneous graphical feedback inherent in SRS should facilitate students' capacity to self-monitor and self-assess. The use of SRS may serve as a bridge to increase students' metacognition, for it may encourage students to assume responsibility for the associated self-regulatory processes of monitoring, attention control, and goal setting.

SELF-REGULATION, GOAL ORIENTATION, GENDER, AND TECHNOLOGY USAGE

Self-regulated learning includes processes, many of which are metacognitive in nature. Self-regulation is broader than metacognition, however, for it refers to self-monitoring and self-assessment of more than cognition. Research about students' self-monitoring and self-assessment is grounded in motivation and self-regulation theories and has rapidly expanded in the past several decades. Self-regulation is the process of active engagement of setting goals for oneself and engaging the behaviors and cognitive processes that lead to achieving the goals. Self-regulation, positively associated with achievement, includes several processes, such as goal setting, planning, self-monitoring, attention control, self-evaluation, and solicitation of help when needed (Ryan, Pintrich, & Midgely, 2001; Winne, 1995; Zimmerman, 1998; Zimmerman & Risemberg, 1997). Ideally, as they grow older, students' learning behavior should become decreasingly regulated by parents and teachers and increasingly self-regulated (McCaslin & Good, 1996).

Evidence suggests that both academic goal motivational orientation and self-regulated learning are directly implicated in academic performance (Pintrich & De Groot, 1990). Achievement motivation can take several forms, depending on the type of goal orientation of an individual. Students with an intrinsic or mastery goal desire to acquire new knowledge or skills, whereas those with extrinsic or performance goals want to appear competent to others. In addition to being better self-regulators than students with extrinsic goals, students with intrinsic goals tend to interpret failure as a sign that they should expend more effort, evaluate their own performance in terms of the progress they make, and remain relatively calm during tests. In contrast, students with extrinsic goals not only exhibit less self-regulated behavior, but tend to interpret failure as a sign of low ability, evaluate their progress in terms of how they compare with others, and often are quite anxious about tests (Wigfield & Eccles, 2002).

The discussion of gender differences in achievement typically focuses on the very small differences between boys and girls in verbal abilities, with females showing slightly higher verbal ability and males showing slightly higher visual-spatial ability. These differences are quite small, with considerable overlap between the two groups. In recent years, some researchers have found that these

differences are getting even smaller (Halpern & LaMay, 2000). When it comes to achievement motivation, females tend to be more concerned than males about doing well in school, are more engaged in classroom activities, and more interested in getting a college education (Bins, Steinberg, Amorosi, & Cuevas, 1997). Females prefer tasks at which they know they can succeed, while males are more willing to take academic risks and challenges (Dweck, 2000). Males, unlike females, tend to take their failures in stride, attributing them to lack of effort, whereas females attribute failure to a lack of ability, which can be a debilitating attribution (Dweck, 2000). Despite higher grades for females than males, females tend to underestimate their competence, whereas males tend to overestimate it (Eccles, Wigfield, & Schiefele, 1998). Studies of achievement goal orientation provide some evidence that males are more oriented to extrinsic goals and less oriented to intrinsic goals than are females (Roeser, Midgely, & Urdan, 1996).

Recent research has not reported notable gender differences in the use of technology, although gender differences in perceived self-efficacy regarding complex computer tasks were found over a decade ago (Bush, 1995). In a 1990 study, when paired in a computer lab, males tended to work on the computers while females tended to observe (Arenz & Lee, 1990). Males and females' self-efficacy for various content domains, likely shaped by gender stereotypes, influences the extent to which they value different domains (Bandura, Barararanelli, Caprara, & Pastorelli, 2001). More recently, it was reported that, in general, females do not like the computer game culture (AAUW, 2000). On the surface, the use of clickers in the classroom has a hint of computer gaming technology, i.e., they provide individual electronic interaction with immediate feedback and a score at the end of the session.

As stated previously, the research questions for this study focus on the main and interaction effects of SRS usage according to type of pedagogy (use of operant conditioning or development of metacognition), self-regulation level, goal orientation, and gender. Does a pedagogy based on the behavioral perspective of operant conditioning or a cognitive information processing view with a concentration on metacognition influence achievement? Do the outcomes of these approaches differ according to characteristics of particular individuals, such as gender, self-regulation levels, and goal orientation? How are other outcomes, such as level of anxiety, class preparation, and attendance influenced by the way SRS is implemented?

RESEARCH METHODS

Sample. One hundred twenty students in two undergraduate introductory educational psychology classes participated during fall 2006 in the research study at a large southeastern university. This research project involved the comparison of instructional techniques in an established classroom setting; thus all students enrolled in the class participated. On the first day of class, students were informed of the way that SRS would be used and completed a pretest. Student data also were collected during the weekly CPS quizzes, a post test exam, and an end of course survey (see Procedures and Instrumentation).

Ninety participants were female, and 30 were male, with 90 Caucasian, 24 African American, four Hispanic, and two Asian. These demographic characteristics were evenly distributed across classes. Of the participants, only 2 students previously had used an SRS in another course.

Course Materials. The same instructor taught both sections. The classes met twice a week in the early afternoon for 75 minutes. Both classes used the clickers and had access to the same informational materials and documents within their respective classes in a Blackboard course management system. The Powerpoint presentations, video clips, case study discussions, and other activities were identically sequenced for the two sections. The syllabus for each section differed only with regard to the SRS component and requirement, as described below.

The Behavioral (Operant Conditioning) Group 1: The Grading and Evaluation Component of the syllabus listed all assignments, activities, exam, and the associated points of each. SRS quizzes counted 25% of the final grade.

The Cognitive Information Processing (Metacognitive) Group 2: The Grading and Evaluation Component of the syllabus listed all points associated with assignments, activities, and exam. SRS was listed as an important activity in which students could self-monitor or self-assess their reading comprehension, with no points associated. Performance on the weekly quizzes was informational and educative for the individual student and non-punitive in terms of grades.

Procedures and Instrumentation.

Pretest. The pretest was completed on the first day of class prior to introduction to course documents to measure prior knowledge of course content and to obtain information on students' self-regulatory skills and motivation goals. The pretest was designed for the study and included items based on the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia, & McKeachie, 1991). The MSLQ consists of a motivation section (six subscales) and a learning strategies section (nine subscales). The MSLQ's 15 scales can be used together or individually (Pintrich et al., 1991). Pretest items were based on the following scales: Intrinsic Goal Orientation Scale (α = .74), Extrinsic Goal Orientation Scale (α = .62), Organization Scale(α = .64), Time and Study Environment Management Scale(α = .76), Effort Regulation Scale (α = .69), and Metacognitive Self-regulation scale (α = .79). Multiple choice items measuring prior knowledge of course concepts also were included.

CPS Quizzes. Both groups completed a total of nine SRS quizzes on Thursdays at the beginning of class on material read and discussed since the SRS quiz administered the week before. Each quiz had 10 multiple choice items measuring comprehension and application of key course concepts.

Posttest: Achievement. To obtain achievement data, multiple choice questions on course content from the pretest were administered on an exam. These items measured comprehension and application of course concepts.

End of Course Survey. Students completed an online survey at the end of the course reporting attitudinal and affective responses to using SRS technology. To obtain delayed recall achievement data, multiple choice items from the pretest and exam were also included. These items were slightly modified to reduce the practice effect from the posttest achievement measure.

ANALYSIS AND RESULTS

Data were analyzed in SPSS using MANOVA. The multiple choice item pretest measuring prior knowledge was not used as a covariate as no variability was found among students. For MANOVA, the assumption that the error variance of the dependent variable is equal across groups was met (i.e., Levene's Test of Equality of Error Variances was not significant (Exam 1, p =.37; Anxiety, p = .76; Preparation and Attendance, p = .68). Mean scores and standard deviations on the dependent measures are reported in Table 1 for type of pedagogy and self-regulation level. As shown in Table 2, no significant main effects exist for type of pedagogy on achievement on the Exam, F(1, 119) = 1.318, p = .254. A main effect for type of pedagogy on level of anxiety and class preparation and attendance was found for Preparation and Attendance, F(1, 114) = 23.43 , p <.001, and for Anxiety, F(1, 110) =12.84 p < .01. Table 1 shows that students in the operant conditioning group were more motivated to attend and prepare for class at a statistically significant level than the metacognitive group. In addition, the operant conditioning group was more likely to be anxious than the other group when using SRS. Shown in Table 2, no main effects existed for gender or goal orientation on achievement, anxiety level or class preparation and attendance. A main effect on achievement for level of self-regulation was found F(1, 110) = 6.83, p < .01, with Table 1 displaying the unexpected finding that students with low self-regulation scored higher than highly self-regulated students.

As displayed in Table 3 (page 170), interaction effects also were examined. No interaction effect was found between type of pedagogy and gender, although level of anxiety and classroom preparedness and attendance approached a significant level. Several two-way interaction effects were found among other factors. Type of pedagogy and self-regulation level interacted significantly on the achievement measure F(1, 110) = 14.32, p = .001. Highly self-regulated students in the metacognitive group scored significantly higher than those in the

Table 1: Mean Score and Standard Deviation of Achievement, Attendance and Preparation, and Anxiety Dependent Measures by Type of Pedagogy and Level of Self-Regulation

Source		Dependent Measures		
		Achievement (Exam 1)	Attendance/ Preparation	Anxiety
		Mean(SD)	Mean(SD)	Mean(SD)
Type of Pedagogy	Operant Conditioning	13.4(2.3)	6.8 (1.0)*	3.0(.6)*
	Metacognitive	13.6(1.9)	5.3(1.2)*	2.4(.7)*
Level of Self-Regulation	Low	13.7(2.1)*	6.0(1.3)	2.6(.77)
	High	13.0(1.7)*	6.02(1.4)	2.7(.67)

**Means are significantly different between groups, p<.01*

Table 2: Main Effects of Type of Pedagogy, Gender, Level of Self-Regulation, and Goal Orientation on Achievement, Anxiety, Preparation, and Attendance

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Type of Pedagogy	Exam	4.762	1	4.762	1.318	.254	.014
	Level of Anxiety	6.310	1	5.430	12.838*	.001	.174
	Preparation and Attendance	40.056	1	32.341	23.434*	.000	.278
Gender	Exam	2.535	1	2.535	.702	.404	.007
	Level of Anxiety	.399	1	.181	.428	.515	.007
	Preparation and Attendance	2.061	1	1.207	.875	.353	.014
Self-Regulation Level	Exam	24.704	1	24.704	6.837*	.010	.066
	Level of Anxiety	.300	1	.217	.513	.476	.008
	Preparation and Attendance	2.571	1	.281	.203	.654	.003
Goal Orientation	Exam	4.590	2	2.295	.635	.532	.013
	Level of Anxiety	.012	1	.657	1.553	.220	.048
	Preparation and Attendance	7.398	1	.922	.668	.516	.021

**indicates significant effect*

same group with low self-regulatory skills and highly self-regulated students in the operant conditioning group.

Gender and goal orientation also interacted significantly on the Exam $F(1, 110) = 7.45$, $p = .001$, with males having an extrinsic goal orientation significantly scoring higher than intrinsic goal oriented males and extrinsically goal oriented females. Intrinsic goal oriented female students, however, scored higher than extrinsic goal oriented males, but not at a significant level. Gender and self-regulation also interacted significantly, $F(1, 110) = 7.9$, $p=.006$, with males with low self-regulation scoring better than males with high self-regulation.

Also shown in Table 3, three-way interactions were detected, which clarify these two-way effects. Significant interaction effects of level of self-regulation, goal orientation, and gender on the exam were found, $F(1, 110) = 3.67$, $p < .05$. Males with high extrinsic goals significantly outperformed intrinsic goal oriented males. Table 4 (page 171) displays the mean scores on the Exam by gender, goal orientation, and self-regulation. As shown in Table 4, these high extrinsic goal males outscored high self-regulated males with an intrinsic goal orientation. High extrinsic goal male students with high self-regulation also outscored both intrinsic and extrinsic goal oriented female students, but not at a significant level.

Table 5 (page 171) shows that males in the operant conditioning group with low self-regulation scored significantly higher than highly self-regulated male

Table 3: Interaction Effects of Type of Pedagogy, Gender, Self-Regulation, and Goal Orientation on Achievement, Anxiety, Preparation, Attendance

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Type of Pedagogy * Gender	Exam	.374	1	.374	.104	.748	.001
	Level of Anxiety	1.454	1	5.048	10.541	.002	.136
	Preparation and Attendance	4.617	1	26.620	18.960	.000	.221
Type of Pedagogy * Self-Regulation Level	Exam	51.743	1	51.743	14.321*	.000	.13
	Level of Anxiety	1.310	1	.328	.686	.411	.010
	Preparation and Attendance	.394	1	1.892	1.348	.250	.020
Gender * Type of Pedagogy * Self RegLevel	Exam	18.457	1	18.457	5.108*	.026	.051
	Level of Anxiety	1.953	1	1.953	4.078	.047	.057
	Preparation and Attendance	1.479	1	1.479	1.053	.308	.015
Gender * Goal Orientation	Exam	53.839	2	26.920	7.451*	.001	.134
	Level of Anxiety	.632	2	.316	.659	.521	.019
	Preparation and Attendance	4.199	2	2.099	1.495	.232	.043
Gender * Self-Regulation Level	Exam	28.532	1	28.532	7.897*	.006	.076
	Level of Anxiety	3.100	1	.011	.024	.879	.000
	Preparation and Attendance	4.218	1	.085	.061	.806	.001
Gender * Self Regulation Level * Goal Orientation	Exam	26.705	2	13.353	3.696*	.028	.071
	Level of Anxiety	1.318	1	1.318	2.753	.102	.039
	Preparation and Attendance	.291	1	.291	.207	.650	.003

** Indicates a significant level*

students in both pedagogical groups. The operant conditioning group males with low self-regulation also outscored all females, although not at a significant level.

WHAT DOES ALL OF THIS MEAN?

The first research question was: Does the instructional approach of SRS use differentially influence student achievement? Findings did not suggest that one approach to using SRS was better than the other in terms of student achievement. Students' understanding and ability to apply course concepts were equal

Table 4: Mean Scores on Exam by Gender, Level of Self-Regulation, and Goal Orientation

Gender	Self-Reg Level	Goal Type	Mean	Std. Error
Male	High Self-Reg	Intrinsic	12.500*	1.344
		Both	11.417	.776
		Extrinsic	14.500*	1.344
	Low Self-Reg	Intrinsic	13.933	.694
		Both	14.167	.776
		Extrinsic	13.750*	.950
Female	High Self-Reg	Intrinsic	14.188	.475
		Both	14.056	.501
		Extrinsic	11.917	.726
	Low Self-Reg	Intrinsic	14.183	.506
		Both	13.364	.405
		Extrinsic	12.952	.656

**Means are significantly different between groups.*

Table 5: Mean Scores on Exam by Gender, Type of Pedagogy, and Level of Self-Regulation

Gender		Type of Pedagogy		Self-Reg Level		Mean	Std. Error
	N		N		N		
Male	32	Soc. Cog.	19	High	8	12.417*	.776
				Low	11	13.250	.607
		Operant Conditioning	13	High	4	12.500*	.950
				Low	9	15.100*	.694
Female	88	Soc. Cog.	41	High	20	14.398	.478
				Low	21	13.360	.501
		Operant Conditioning	47	High	18	12.375	.466
				Low	29	13.640	.357

**Means are significantly different between the groups.*

in both sections, regardless of type of pedagogy. This finding was unexpected, as the researcher hypothesized that the approach of using SRS to develop metacognitive processes, such as self-monitoring and self-assessment, would be associated with higher achievement. Answers to other research questions clarify this finding, however.

The second research question asked: Does pedagogical approach interact with individual differences, specifically, gender, level of self-regulation, and goal orientation?

The preliminary evidence from this study suggests that specific student characteristics, such as gender, self-regulation, and goal orientation, play a role in the effectiveness of SRS on achievement. As hypothesized, type of pedagogy and self-regulation level interacted significantly on the achievement measure $F(1, 110) = 14.32$, with highly self-regulated students in the metacognitive group significantly outperforming those in the same group with low self-regulatory skills. Highly self-regulated students in the metacognitive group also scored better than highly self-regulated students in the operant conditioning group. The partial Eta squared was .13, so this effect accounted for 13% of the variance. This finding supports research that self-regulation is positively associated with achievement (Ryan, Pintrich, & Midgely, 2001; Winne, 1995; Zimmerman, 1998). Moreover, this interaction suggests that the aim of the metacognitive approach, that is, to develop the cognitive processes of self-monitoring and self-assessing, is a worthwhile effort for an instructor to pursue with or without SRS technology. SRS technology, despite the lack of a main effect of instructional approach, nevertheless provides a promising way for students in large classes particularly to be able to develop these self-regulatory skills.

Gender and goal orientation also interacted significantly on the Exam $F(1, 110) = 7.45$, $p = .001$, with males having an extrinsic (performance) goal orientation significantly outperforming intrinsic goal oriented males, and extrinsic goal oriented females. The partial Eta squared for gender and goal orientation on the achievement measure accounted for 13.4% of the overall variance. That extrinsic goal oriented males outscored other students is not surprising, for studies of achievement goal orientation provide some evidence that males are more oriented to extrinsic goals and less oriented to intrinsic goals than are females (Roeser, Midgely, & Urdan, 1996).

Gender and self-regulation also interacted significantly, $F(1, 110) = 7.9$, $p=.006$, surprisingly, with males with low self-regulation outperforming males with high self-regulation. This is not consistent with the self-regulation literature. The interaction of gender and goal orientation with self-regulation, however, provides an explanation for this finding, for extrinsic goal oriented males outperformed males with an intrinsic goal orientation—regardless of self-regulation level. This aligns with research findings that males are more oriented to extrinsic goals previously mentioned. In addition, the 3-way interaction effect of gender, type of pedagogy, and self-regulation level sheds light on the finding that male students with low self-regulation level significantly outperformed highly self-regulated students. Low self-regulation is associated with lower achievement, yet in the operant conditioning group, male low self-regulators who also had a high extrinsic goal orientation significantly outscored highly self-regulated males and females. In terms of practical significance, however, the effect size is small, with only 5% of the effect explaining the overall variance on the exam. Nevertheless, the operant conditioning approach appears to have provided a context for some males to successfully achieve, despite low self regulation. Again, this is consistent with some previous research about a likelihood of extrinsic goal orientation in males.

The third research questions asked: Are other student outcomes (level of anxiety, class preparation and attendance) influenced by the pedagogical approach

of SRS use? Findings from this study strongly support previous research that found that electronic student response systems influence students' participatory behavior and active engagement (Hake, 1998; Poulis et al., 1998). The operant conditioning approach significantly increased class preparation and attendance ($F = 23.43$), which is consistent with previous research, but also increased student anxiety ($F = 12.84$). From a practical standpoint, however, the effect size was modest for anxiety. The partial Eta squared was 13.6, which means that type of pedagogy accounted for only 13.6% of the overall (effect + error) variance. The effect size for class preparation and attendance approached a moderate level, with an Eta squared pf .22—i.e., type of pedagogy accounted for 22% of the overall variance. It appears that having SRS count as part of the grade contributes moderately to students preparing for and attending class. Students may have been either positively or negatively reinforced as their preparing and attending behaviors increased in frequency. Yet several students in this group voiced openly that they dreaded the CPS quiz, so for at least some students, negative reinforcement was occurring. In general, SRS used as reinforcement can increase behaviors related to class participation and engagement that may be desirable to instructors.

Previous research has found that extrinsic goal oriented students tend to evaluate their progress in terms of how they compare with others and are often quite anxious about tests (Wigfield & Eccles, 2002). This finding was not supported in this study, as no significant relationship between anxiety and goal orientation was found. In addition, no gender differences as to the extent that students liked using and valued SRS as a learning tool were noted. This is consistent with recent research, which has not found notable gender differences in the use of technology, although in general, females do not like the computer game culture (AAUW, 2000). Females and males in this study were equally positive about SRS. For females, these clickers were not perceived as an academic by-product of gaming culture.

Other secondary findings also are noteworthy. Students who used SRS as a metacognitive tool reported that they liked using SRS significantly more than students in the operant conditioning group, who tended to associate its use with a quiz. Students in the metacognitive group also reported that they were able to learn from errors they made on quizzes and liked not being penalized for an incorrect answer. These students also reported that they would be more likely to use the technology in their future classrooms.

FUTURE DIRECTIONS

In summary, findings from this study suggest that the more effective pedagogy is contingent on the instructors' goals: If the instructor seeks to foster students' adoption of intrinsic or mastery goals and encourage the development of self-regulatory skills, both of which are positively associated with achievement, the use of student response technology systems should be grounded in a cognitivist perspective. On the other hand, if the instructor wishes to influence class preparation and attendance, SRS should be utilized within an operant conditioning framework.

This study sought to address a deficit in SRS literature on effective pedagogical practices, for "Ultimately, … the pedagogical practices of the instructor, not the incorporation of the technology [is] key to student comprehension" (Judson & Sawada, 2002, p. 167). SRS is not "a 'magic bullet' to educational woes, these systems are merely tools which can be used in any number of ways. It is time to move beyond anecdotes and beyond traditional classroom pedagogies" (Fies & Marshall, 2006, p. 106). Research and professional development should continue to focus on specific pedagogical practices for student response technology based on individual differences, including self-regulation and motivation goal orientation and also pedagogical practices appropriate for diverse populations. Certainly, practices that use SRS in group mode should be further examined, including "varying degrees of anonymity in response collection" (Fies & Marshall, 2006, p. 106).

Much of the current research has been conducted in the areas of physics and biological sciences. Other pedagogical uses that promote concept development in other content areas are needed. In particular, effects of types and sequencing of questions on student conceptual development and specific ways in a content area to build concepts through student discussion and feedback should be investigated. Further research related to connections the technology can make to broader educational and psychological literature, such as formative assessment through questioning and feedback, also is warranted.

A multitude of other uses of SRS warrants empirical investigation, given the powerful push of individual accountability and the fact that this technology is becoming more robust and affordable. As research on SRS expands and more is known about its affordances and limitations, perhaps its use can influence student learning and transform traditional classrooms to more learner-, knowledge-, and assessment-centered contexts and learning environments conducive to fostering conceptual development and deep understanding.

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