A SURVEY OF K-12 TEACHERS

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Background

Student response systems are a mature, scaleable technology that has the potential to improve classroom participation and student achievement (Roschelle, Penuel, & Abrahamson, 2004). Such systems entail sets of "clickers" with radio transmission of input, enabling teachers to pose questions of all students and gain immediate feedback about student understandings in a class. When used in conjunction with interactive teaching strategies such as peer discussion, such systems have been shown in past studies to produce gains in conceptual understanding in science (Crouch & Mazur, 2001).

Most studies of student response systems have examined teaching and learning outcomes at the undergraduate level, yet such systems are becoming much more widespread in K-12 settings. For example, eInstruction, whose users were surveyed as part of the current study, has distributed over one million response pads to elementary, middle, and high school students. At present, little is known about how teachers use these kinds of response systems in K-12 settings or what they believe about the effectiveness of such systems. The current questionnaire study is a first step toward understanding how teachers in K-12 settings integrate student response systems into their teaching.

Research Questions

Through an initial survey study of teaching with response systems, we sought to address the following four research questions:

- For what purposes do K-12 teachers use student response system technologies?

- In what classroom contexts do K-12 teachers use response systems?

- Can we identify distinct "profiles of use" of response systems among teachers using these systems?

- If so, are such profiles associated with particular characteristics of teachers, classrooms, or professional development experiences?

- Do perceptions of the effects response systems on teaching and learning correlate with particular profiles of use?

Study Design

Technology All survey respondents were current users of eInstruction's *Classroom Performance System*. Among other capabilities, this system allows users to perform tasks that are considered essential by researchers in this area: pose questions in the system, collect and aggregate student responses, and display them in a histogram or other summary form. To use the system, a desktop or laptop computer is required, as are eInstruction's response pads ("clickers") and infrared- or radio-frequency enabled receiver unit.

Sample A total of 585 K-12 teachers completed at least part of the questionnaire. Of these 35.7% (n = 209) were elementary school teachers, 29.7% (n = 174), and 34.4% (n = 201) were high school teachers. The median years taught for the sample was 11 years. The teachers in the sample had been using the CPS for a median of 2 semesters at the time they completed the

survey. Nearly all (94%) had adopted CPS by choice, most often having been offered the opportunity to use it by someone else at no cost to themselves. More details on teachers' assignments and classroom contexts appear in the results section of the report.

Instrument The study relied on a single questionnaire developed jointly by two of the authors from SRI International (Crawford and Penuel) and Santa Clara University (Urdan). The questionnaire included items designed to elicit teachers' goals for using the system, teaching practices when using the system, and perceived effects of system use on teaching and learning. Past research on response system technology usage in higher education was used to develop the items, which were pilot tested with two teachers who use response systems. Exploratory factor analysis was used to analyze the reliability of scales for goals, teaching practices, and perceived effects. Reliabilities for all items were moderate to high; more detailed results of the factor analysis are available in a separate report (Boscardin & Masyn, 2005).

Procedure All participants were contacted through their eInstruction system and via a company newsletter to solicit their participation. Participants were given a 17-week window during the winter of 2004-05 to complete the survey. We provided a $10 gift certificate to all respondents who completed a questionnaire; as a further incentive to complete the questionnaire, all respondents were entered in a drawing to win one of five CPS systems from eInstruction.

Analysis The report authors from UCLA (Boscardin) and UC-Davis (Masyn) conducted latent class analysis to identify profiles of CPS users. Latent class analysis has as its goal to understand the similarities and differences in response patterns across individuals in a particular data set; these patterns are grouped into profiles defined by probabilities of specific responses on specific items. Furthermore, each teacher in the sample can be assigned to the specific profile that best corresponds to his/her pattern of responses across questions. These researchers then conducted analyses of associations among different use profiles on the one hand and the goals, practices, and perceived benefits of response system technologies, on the other hand. Analysis of basic descriptive statistics regarding goals, contexts of software use, and perceived benefits was conducted by the first author (Penuel).

Results

In this section, we analyze the different purposes for response system use for teachers in the sample, the classroom contexts of CPS use, profiles of use, and associations of profiles of use with classroom characteristics, professional development experiences, and perceptions of effectiveness.

Goals for Using Student Response System Technology

The exploratory factor analysis indicated that there were two basic kinds of goals that teachers adopted for using response system technology. One set of goals-related items in Table 1 is associated primarily with improving learning and instruction, while the other is associated with using the system for assessment and feedback purposes. Both were generally endorsed as important by teachers who completed the questionnaire.

Table 1. Teachers' Goals for CPS Use: Mean Ratings of Importance

Goal	M	SD
Improving learning and instruction		
To gain a better understanding of what students do and do not understand	4.56*	0.79
To promote student learning	4.55	0.79
To increase the effectiveness of instruction overall	4.50	0.83
To increase student attention and activity during lectures	4.34	0.95
To make students more aware of their conceptual understanding	4.33	0.91
To stimulate class discussion about an idea or concept	4.17	1.03
To differentiate or individualize instruction	3.12	1.03
Improving assessment and feedback		
To get instant feedback from students	4.62	0.76
To increase teacher productivity	4.33	0.92
To save time required for scoring formal or informal assessment	4.28	1.05
To assess student learning (for purposes of assigning grades)	4.24	1.02
To enhance feedback to students about their understanding of target concepts and ideas	4.23	1.01

Importance rating; scale: 1 = not important; 5 = very important

Classroom Contexts of Student Response System Technology Use

The teachers in the sample used the CPS systems for a variety of subjects, across different levels of the educational system. Table 2 shows how many teachers at each level reported using student response system technology for different subjects. The number is larger than the total number of teachers because some teachers use the system for multiple subjects.

Table 2. Teachers' Use of the CPS in Different Subjects

	Elementary School Teachers	Middle School Teachers	High School Teachers
English/Language Arts	160 (76.6%)	59 (33.9%)	37 (18.4%)
Mathematics	153 (73.2%)	63 (36.2%)	47 (23.4%)
Social Studies	127 (60.8%)	39 (22.4%)	30 (14.9%)
Science	128 (61.2%)	54 (31.0%)	52 (25.9%)
Biology	Not asked	31 (17.8%)	27 (13.4%)
Chemistry	Not asked	13 (7.5%)	20 (10.0%)
Physics	Not asked	9 (5.2%)	13 (6.5%)
Integrated Science/ Earth or Physical Science	Not asked	44 (25.3%)	25 (12.4%)
Foreign Languages	Not asked	3 (1.7%)	4 (2.0%)
Other	Not asked	39 (22.4%)	4 (2.0%)

As the table above indicates, elementary school teachers were most likely to use the CPS across subject matters, in all likelihood because they have responsibility for multiple subjects in the curriculum. The plurality of middle school teachers used the system for mathematics, with a substantial percentage of teachers also using the system for science and English/Language Arts. In high school, the plurality used the CPS for science, with significant percentages also using the system for mathematics and English/Language Arts. Respondents who marked "other" were not asked to describe their use.

Profiles of Use

From the latent class analysis, we selected a four-class model as the best fit to the survey data from teachers. In other words, a solution that included four different profiles of use was found through a series of information theoretic model comparisons (see Boscardin & Masyn, 2005) to characterize the dominant patterns of responses regarding CPS usage. To describe and interpret the different profiles of use, it is necessary to examine the likely response categories for each CPS usage question for each profile and compare those likely response categories across the profiles. In this way, one can understand the responses most characteristic to each profile as well as identify the CPS usage items that most distinguish between the profiles of use. Below, we describe the different profiles of use that emerged from the analysis of survey data.

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Profile 1: Infrequent User. Teachers with this profile of use tend to use the CPS rarely. When they do use the system, they tend not to use the full range of capabilities of the system or not to use a variety of pedagogical strategies in conjunction with use of the system. They rarely use data from the system to adjust their instruction. There were 63 teachers (12.7%) in the sample whose responses corresponded most closely with this profile.

Profile 2: Teaching Self-Evaluator. Teachers with this profile of use tend to use the CPS often, and they use the system primarily to gain feedback on the effectiveness of their own teaching. They usually use the system for summative assessment purposes, and less frequently for formative assessment purposes. They rarely involve students in peer discussion, and only sometimes use the CPS to prompt whole-class discussions. They occasionally use data from the system to adjust their instruction. There were 137 teachers (27.5%) in the sample whose responses corresponded most closely with this profile.

Profile 3: Broad but Infrequent Users. Teachers with this profile of use tend to use the CPS somewhat less frequently than self-evaluators, but they use the system for a wider range of purposes. When they use the system, they use it for both formative and summative assessment. They sometimes involve students in peer discussion, and sometimes they use the CPS to prompt whole-class discussions. They occasionally use data from the system to adjust their instruction. There were 173 teachers (34.7%) in the sample whose responses corresponded most closely with this profile.

Profile 4: Broad and Frequent Users. Teachers with this profile of use tend to use the CPS frequently, and they use the system for a wide range of purposes. When they use the system, they use it for summative purposes and for formative purposes. They sometimes or often involve students in peer discussion, and often they use the CPS to prompt whole-class

discussions. They sometimes use data from the system to adjust their instruction. There were 125 teachers (25.1%) in the sample whose responses corresponded most closely with this profile.

Teacher Characteristics Associated with Profiles of Use

We analyzed whether teachers' experience and past use of CPS and other technologies were associated with assigned use profiles. None of the characteristics of teachers we examined was associated with particular profiles of use, except for use of other kinds of computer technologies in classrooms with students. We did not find a significant association between years of teaching and profile ($p = 0.281$) or experience with using the CPS ($p = .37$). However, we did discover that teachers using other computer technologies 1 to 2 times a month or less were most likely to be in the "infrequent user" class and least likely to be in the "broad and frequent user" class ($p = .022$).

Classroom Characteristics Associated with Profiles of Use

We examined whether school level taught, subject matter for which CPS was used, and technology access were associated with profiles of use. None of these classroom-level variables was associated with particular profiles of use.

Professional Development Experiences Associated with Profiles of Use

We examined whether preparation in technical and pedagogical aspects of response system use was associated with particular profiles of use. We found that training in instructional strategies to use in conjunction with the CPS increased the likelihood that a teacher would be a "broad and frequent user" and decreased the likelihood that they would be a "non-user" ($p = .005$). We found there was no significant association between how much training was received with respect to technical aspects of using the system and profiles of use ($p = .205$).

Perceived Effectiveness and Profiles of Use

We examined whether teachers with particular profiles of use perceived the CPS to be more or less effective in their classrooms. We examined three different dimensions of effectiveness: enhancing feedback on learning; improving the classroom environment; and enhancing student learning and engagement. In addition, we examined the association between profiles and overall perceptions of the benefits of using the CPS. It should be emphasized that these are correlations between self-reported practices and teachers' perceptions of benefits.

We found that in each case, teachers who were broad, frequent users of CPS were much more likely to report benefits than other kinds of users. In addition, the infrequent users were much more likely to report lower levels of benefits of using the CPS than teachers with other profiles of use. Table 3 shows the significance of the associations between class membership (profile) and specific benefits. Two interpretations of these correlations are possible: One is that teachers perceive less benefits to teaching and learning therefore use the system less; the other is that teachers' who use the system more frequently tend to use the system more broadly and therefore observe more and more varied benefits from using the system.

Table 3. Associations between Class Membership (Profiles) and Reported Benefits

Reported Benefit	F	df	P
Enhanced feedback to students	35.87	3,461	<.001
Improved classroom environment	10.98	3,461	<.001
Improved learning and engagement	22.97	3,461	<.001
Overall benefits	23.34	3,458	<.001

Discussion

Our survey results indicated that K-12 teachers used the CPS in a variety of subjects. Although the research on student response systems in higher education tends to be focused on science, these survey results suggest that at the K-12 level at least some research should examine the use of such systems in other subjects, such as mathematics and language arts. Foreign language is not well-represented in the sample; it may represent a domain in which it is challenging for teachers to adopt student response systems productively, since oral responses to teacher questions may be necessary in language classes.

Another important finding from the survey is that teachers use the CPS system for both assessment and instruction. These findings are consistent with research on student response systems in higher education, which emphasize benefits of improved assessment data for teachers and improved engagement and instructional experiences for students. These findings are also consistent with research conducted by other researchers in formative assessment, who emphasize that at its best, good formative assessment becomes seamlessly integrated with good instruction (National Research Council, 2001).

Our survey data did reveal that there was among CPS users a significant difference between those who use the system for summative assessment, rather than formative assessment, purposes. The exploratory factor analysis found a relatively lower correlation ($r = 1.31$) correlation between items intended to tap formative uses of the CPS and items intended to measure more summative uses of the system. The factor analysis also indicated stronger correlations ($r = .41$) between items intended to tap formative uses of the CPS and items intended to measure whether teachers used the CPS in conjunction with peer discussion, a use associated more with instructional uses of the system.

From these data, we would anticipate that teachers who use the system for summative assessment will tend to use the system primarily for assessment, while those teachers who use the system for more formative assessment will also use the system for instructional purposes. In other words, teachers who valued the system for its feedback to them and time-saving affordances would use it for judging whether students had mastered particular concepts, while teachers who sought to increase student attention and stimulate discussion would tend to use data from the system formatively to adjust their instruction. The latent class analysis supported this prediction; there emerged one user profile whose primary use was limited to summative assessment, and two other classes of users who tended to combine formative assessment with instructional uses of the CPS. A fourth user profile showed infrequent use of the system.

The profile of users who used the system for formative assessment and for engaging students more in discussion of the CPS is of particular interest for future studies, because of the significant correlations between membership in this class and several other variables in our analysis. Frequent, broad users of the CPS were much more likely to perceive the CPS as conferring a range of benefits to themselves and to students. In addition, frequent, broad users of the CPS were more likely to report that they had more hours of professional development in how to teach with the system than other classes of users, suggesting that if membership in this group is to be promoted, professional development in pedagogies may be necessary to provide.

Limitations of the Study

Our study represents a first attempt by researchers to investigate teaching with student response systems in K-12 settings. Most research has been conducted on how these systems are used in higher education; our research was intended in part to determine whether practices reported in the research on teaching with response system technology in higher education are also used by teachers in elementary and secondary education.

Although our sample was large, we cannot say whether it is a representative sample of teachers. Teachers volunteered to complete the questionnaire, and we had no means for selecting a sample systematically from a list of eInstruction customers to survey. Therefore, we cannot make claims about the prevalence of particular teaching practices used in conjunction with response systems. However, as we have done here, we have attempted to show for the teachers who did participate in the survey different profiles of use and how they relate to perceived benefits of using the CPS.

This study also does not allow us to determine what effects CPS use has on teaching and learning, or whether it enhanced learning in any of the classrooms from which teachers were surveyed. In our study, there was no independent measure of teaching practice or student learning; nor did we attempt to design an impact study with random assignment. Both independent measures and a more rigorous design would be necessary to make claims about the impact of using the CPS on student learning and engagement.

Finally, the findings from this study are likely to generalize to users of systems with similar functionality to CPS, but may or may not generalize to response systems with different kinds of functionality. We chose the CPS as a system to study because it is broadly used and representative of a class of student response systems, in terms of its design and functionality. However, there are other types of systems that combine response system functionality with the ability to engage students in participatory simulations and modeling activities (Kaput & Hegedus, 2002; Stroup, 2002; Wilensky & Stroup, 2000). These systems enable different forms of student participation, and they require different forms of teaching than have been documented in the literature on the use of student response systems in higher education. The teaching strategies that might be used with such systems have not been widely implemented to date, however, and are not as susceptible to measurement as were the practices we measured as part of our survey.

Conclusions and Directions for Future Studies

From the survey study, we can conclude that many of the teaching practices that researchers report instructors in higher education use in conjunction with response system technology are also used at the K-12 level. As in higher education, teachers use response system technology for both instructional and assessment purposes. Many of them also use it to stimulate peer and classroom discussion. As in higher education, there is a sense that both peer and classroom discussion are important to making the system more effective in the classroom.

From the study, we can also make some specific hypotheses about teaching with response systems that could be investigated in future studies. We would hypothesize that students in classrooms where teachers use the systems frequently and in conjunction with a broad range of teaching strategies will benefit more than would students in classrooms where there are response systems but where those systems are used less frequently and only for summative purposes. We would hypothesize that the benefits would be three fold: there would be improved feedback to students, an improved learning environment, and enhanced learning and engagement. Finally, we would also hypothesize that teachers need to receive professional development in how to teach with response systems in order to adopt the systems to a level involving broad, frequent use with students.

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