Article

Piloting Classroom Response Systems in Graduate Psychology Courses

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Abstract

This study examined student experiences of using classroom response systems (CRS; i.e., clickers) in graduate-level psychology courses. A total of 98 students participated in a repeated measures design. Overall, student attitudes toward using clickers were positive at both measurement time points. Participants reported that clickers helped check comprehension of lectures, increased enjoyment of lectures, helped apply concepts to practical examples, and made the class more engaging. Ratings were less positive for exam preparation and prompting discussions with classmates. This study demonstrates potential applications of CRS in small graduate psychology classrooms and supports previous research indicating that CRS can improve learning by increasing interactivity and higher order processing of information.

Keywords

clickers, classroom response systems, technology, teaching, graduate students

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Much of the research to date on classroom response systems (CRS) has focused on undergraduates in large classes in the fields of mathematics and sciences (Kay & LeSage, 2009). These studies have generally reported positive results in terms of student engagement, participation, grades, and enjoyment of class sessions (Atlantis & Cheema, 2015; Bruff, 2009; Dallaire, 2011; Kay & LeSage, 2009; Shaffer & Collura, 2009), although some studies have found weak relationships between clicker use and learning outcomes, after partialing out the effects of receiving feedback from the instructor (Anthis, 2011; Landrum, 2015). However, there is relatively little research on the use of CRS in small classes, and even less with graduate student samples. Researchers have recommended examining clickers in small classrooms to broaden our knowledge of the ways in which clickers may enhance student engagement (Campbell & Monk, 2015). The aims of this study were to assess the impact of clicker technology, a common form of CRS, on student engagement and self-reported learning in relatively small master's- and doctoral-level psychology courses.

Previous studies examining clicker use in graduate-level classrooms have measured a range of outcomes using various methods, resulting in a heterogeneous set of findings that is relatively limited in scope. One study that included graduate students along with undergraduates used an experimental paradigm and assessed both student and instructor perceptions of clicker use and their impact on engagement and feedback (Bartsch & Murphy, 2011). The results indicated that students who used clickers scored higher on a comprehension quiz. However, given the use of an experimental paradigm, the ecological validity of these findings is unclear. Deleo, Eichenholtz, and Sosin (2009) used clickers as part of a graduate-level course in information literacy and found that clickers improved the instructor's ability to accurately assess students' learning in real time and that clickers increased student engagement. The finding that clickers improved real-time formative assessment and engagement was also reported by Sevian and Robinson (2011), who used clickers in a very small graduate-level class of five students. There is also some evidence that the anonymity of clickers allows students to express their opinions in a way that still contributes constructively to the learning environment, decreasing barriers to engagement that exist even in small classes (Calderon, 2013). Altogether, these findings indicate that clickers have the potential to enhance learning and engagement in small graduate classrooms, but more research is needed to conceptually replicate and clarify these findings.

One benefit of using clicker technology is its flexibility to be incorporated in different types of learning activities (Marlow, Wash, Chapman, & Dale, 2009). However, this also means that the measurement of their effectiveness is related to the instructor's pedagogical framework and intended uses for the clickers. In the present study, the author had two pedagogical aims that determined how clickers were used. First, clickers were used specifically to increase student engagement and active learning, with the expectation that this would, in turn,

improve learning outcomes as demonstrated by previous research (Anthis, 2011; Blasco-Arcas, Buil, Hernández-Ortega, & Sese, 2013; Campbell & Monk, 2015; Cleary, 2008; Jones, Crandall, Vogle, & Robinson, 2013; Landrum, 2015). Second, clickers were used to improve formative assessment during class sessions, with the expectation that this would allow the instructor to identify concepts that needed further clarification and also that students would benefit from using this formative feedback in their ongoing learning (Jacoby, Heugh, Bax, & Branford-White, 2014). Clickers give the instructor a flexible and efficient way of assessing student learning in real time (Bruff, 2009), which again, in turn, increases the likelihood that students are learning the material more deeply and accurately (Ioannou & Artino, 2010). The first author's pedagogical approach emphasizes active learning and application of material over rote memorization and recall, and the clicker questions were designed to help students apply concepts to novel situations. Therefore, we decided it was appropriate to use student perceptions of engagement and learning to assess the effectiveness of clickers, as opposed to exam or quiz scores.

A common and valid critique of the use of clickers in the classroom is that they may improve engagement and learning due to a novelty effect (Campbell & Monk, 2015), as opposed to a unique effect of the clickers themselves. To address this critique, we used a repeated measures design in which attitudes toward clickers were measured at two time points: the middle of the academic term and the end of the academic term. We reasoned that this could help disentangle a possible novelty effect from the clicker effect.

Method

Participants

In this study, clickers were used in five different classes over a period of three consecutive academic terms. One of these terms was a summer term, in which class sessions occurred twice a week for 7 weeks (instead of once a week for 15 weeks during the fall and spring terms). Table 1 provides information on the demographic characteristics of the sample. Across all classes, the total sample size was 98 (71 master's-level students, 27 doctoral-level students). After removing participants who provided incomplete data, the resulting sample size used for analysis was 65 (47 master's-level students, 18 doctoral-level students). The average age of participants in the total sample was 29.35 years ($SD = 5.98$), 90.8% of the sample identified as female and 9.2% as male. The average self-reported grade point average of the sample was 3.91 ($SD = 0.14$). Of the five classes in which clickers were used for this study, only one course was at the doctoral level and was a research methods course. The remaining four courses were at the master's level, two of which were separate classes taking research

Table 1. Demographic Characteristics of Sample.

Variable	*n*	*M* (*SD*)		
Age	65	29.35 (5.98)		
Grade point average	63	3.91 (0.14)		
			Yes	No
Previous clicker use	65		41.5%	58.5%
Class size for usefulness	65	Larger: 44.6%	Smaller: 6.2%	No difference: 49.2%
Gender	65	Male: 9.2%	Female: 90.8%	

methods, and the other two were separate classes taking a class on behavior modification. The instructor for all courses was the first author.

Measures and Materials

Demographic questionnaire. Students were asked to report their age, gender, previous experience with clickers, and cumulative grade point average. This measure was administered to each participant once, at the end of each term.

Usefulness of clickers. We used a single categorical item to assess participant ratings of the overall usefulness of using clickers in their course. This item was intended to be a global assessment of student perceptions toward CRS. Participants were asked to rate the usefulness of CRS as *extremely*, *very*, *somewhat*, or *not at all useful*. This item was administered to each participant twice, at the midpoint of the term and at the end of the term.

Attitudes toward clicker use. Eight items were used to assess attitudes toward clicker use. The items were adapted from a previous study on CRS in psychology classes (Dallaire, 2009), and participants were asked to rate how the use of clickers impacted their understanding of course concepts, enjoyment of classes, engagement in discussions with peers, preparation for exams, application of course concepts to practical examples, engagement, comfort in participating, and overall usefulness of the clickers. Responses were measured on a 4-point Likert scale. These eight items were administered to each participant twice, once at the middle of their class and then again end of the class.

Barriers to using clickers. Four items were used to assess barriers to the usefulness of clickers, and participants were asked to check as many as applied. The items were (a) technical problems disrupted learning, (b) clickers felt like busy work, (c) clickers did not impact engagement, and (d) clickers did not impact motivation. Items (a) and (b) were drawn from a review of the literature (Dallaire,

2011; Sevian & Robinson, 2011). Items (c) and (d) were intended to ascertain the relative impact of clickers on motivation and engagement, as these factors are often confounded with the impact of the clickers themselves. This list of items was administered only once to each participant, at the end of the class.

Qualitative data. At the end of each term, students were given an open-ended question to indicate any additional comments about their experiences using clickers in the classroom. Some of these data are presented in the Discussion section to elaborate on our interpretation of the results.

Clickers. The devices used for this study were purchased from Turning Technologies, LLC using funds from a university-sponsored grant received by the first author. The specific model used was ResponseCard RF.

Procedure

The first author was responsible for distributing and storing the clickers for the duration of the study. At the start of each class period when clickers would be used, each student was given a device which was collected at the end of the class period. Individual students' clicker responses were anonymous, and therefore, students did not need to use the same device in each class period. Informed consent was obtained at the first assessment time point (midway through each term), and students completed a longer questionnaire at the end of the term. The ways in which clickers were used varied according to the course because two of the five classes included in this study had exams, while the remaining three did not. Across all five classes, clicker questions were formulated in the following categories: check comprehension of concepts, stimulate class discussion, gauge student retention, review concepts for exams, survey prior knowledge of a subject, and explore responses to applied clinical situations in psychology. The number of times clickers were used in each course and the number of clicker questions used in each course varied according to the instructor's discretion. In all classes, clickers were used in no fewer than three course meetings and in no more than six course meetings. In all cases, the results of the clicker questions were displayed to the entire class after all responses were recorded. All study materials and procedures were approved by the Institutional Review Board of the institution at which the research was conducted.

Results

Prior to analysis, the data set was cleaned and screened for missing data. Of the entire sample of 98 students, 65 participants (66.3%) provided complete data at both Time 1 and Time 2. For missing data on perceptions of clickers, we elected not to impute values because these variables were measured on an ordinal scale.

Table 2. Usefulness Ratings ($N = 65$).

		Time 1	Time 2
Rate usefulness of clickers as a learning tool	Extremely useful	36.9%	27.7%
	Very useful	36.9%	36.9%
	Somewhat useful	23.1%	29.2%
	Not useful at all	3.1%	6.2%

Therefore, in the analyses reported later, we used data from the 65 participants who provided complete data. Of these 65 participants, there were missing data on one or more demographic items for only 3 participants.

Usefulness of Clickers as a Learning Tool

At both measurement time points, over 60% of participants reported that clickers were *extremely* or *very useful* (see Table 2). However, the proportion of students who rated clickers as *somewhat useful* or *not useful at all* increased from Time 1 to Time 2 (26.1% vs. 35.4%).

Attitudes Toward Clicker Use

Participant responses to these items were varied (see Table 3), and so we present these results in the following categories: Overall more positive at Time 2, overall less positive at Time 2, and overall unchanged at Time 2.

Overall more positive at Time 2. Participants reported increased positive attitudes at Time 2 about the extent to which clickers prompted them to start discussions with classmates, helped them feel more prepared for exams, helped them be able to apply concepts to practical examples, made class more engaging than other classes, and helped them feel more comfortable participating.

Overall less positive at Time 2. Participants reported decreased positive attitudes at Time 2 about the extent to which clickers helped them check how well they understood concepts.

Overall unchanged at Time 2. Participant attitudes were generally unchanged for how well clickers increased enjoyment of lectures.

Table 3. Attitudes Toward Clicker Use ($N = 65$).

		Time 1	Time 2
Check how well I can understand concepts	Strongly agree	64.6%	53.8%
	Somewhat agree	29.2%	18.5%
	Somewhat disagree	0%	6.2%
	Strongly disagree	4.6%	20%
	No opinion	1.5%	1.5%
Increases enjoyment of lectures	Strongly agree	43.1%	44.6%
	Somewhat agree	47.7%	46.2%
	Somewhat disagree	3.1%	3.1%
	Strongly disagree	4.6%	4.6%
	No opinion	1.5%	1.5%
Prompted to start discussions with classmates	Strongly agree	26.2%	18.5%
	Somewhat agree	29.2%	40%
	Somewhat disagree	6.2%	12.3%
	Strongly disagree	10.8%	10.8%
	No opinion	27.7%	18.5%
More prepared for exams	Strongly agree	36.9%	40%
	Somewhat agree	33.8%	40%
	Somewhat disagree	7.7%	3.1%
	Strongly disagree	9.2%	7.7%
	No opinion	12.3%	9.2%
Able to apply concepts to practical examples	Strongly agree	47.7%	44.6%
	Somewhat agree	33.8%	38.5%
	Somewhat disagree	3.1%	6.2%
	Strongly disagree	7.7%	4.6%
	No opinion	7.7%	6.2%
Class was more engaging than others	Strongly agree	44.6%	46.2%
	Somewhat agree	35.4%	35.4%
	Somewhat disagree	4.6%	1.5%
	Strongly disagree	4.6%	9.2%
	No opinion	10.8%	7.7%
Feel more comfortable participating	Strongly agree	36.9%	41.5%
	Somewhat agree	29.2%	27.7%
	Somewhat disagree	6.2%	7.7%
	Strongly disagree	23.1%	7.7%
	No opinion	4.6%	15.4%

Barriers to Learning

As indicated in Table 4, most participants indicated that the listed barriers to learning did not affect them. The most frequent barrier endorsed was that technical problems disrupted the learning process, which is likely a function of

Table 4. Responses to Items Assessing Barriers to Learning ($N = 65$).

Item	Yes	No
Technical problems disrupted learning process	36.9%	63.1%
Clicker questions felt like busy work	4.6%	95.4%
Did not impact motivation to engage in class	24.6%	75.4%
Did not impact ability to engage in class	27.7%	72.3%

clickers being new to both the first author (instructor) and the students. About one quarter of participants reported that the clickers did not impact their motivation to engage in class or ability to engage in class. Less than 5% of participants reported that clicker questions felt like busy work.

Discussion

The aims of this study were to assess the impact of clickers on student engagement and self-reported learning at two time points in relatively small master's- and doctoral-level psychology courses. Overall, student attitudes toward using CRS were positive, and this was sustained at both measurement time points within each term. Some of the items that were consistently rated highly across time points were that clickers helped students check their comprehension of lectures, increased student enjoyment of lectures, helped students apply concepts to practical examples, and made the class generally more engaging. Ratings were less consistently positive for items pertaining to exam preparation and prompting discussions with classmates. One factor that may have influenced this finding is that exams were administered in only two of the four classes used in this study.

The attitudinal items revealed specific aspects of student experiences using clickers in this study. Students' opinions on whether clickers prompted them to start discussions with classmates generally varied. The first author, who was also the instructor of all the courses in this study, designs her courses to be interactive whether or not clickers are a part of the course, so this may have contributed to a ceiling effect in our ability to detect the impact of clickers on class discussions. It may also be that students find certain types of class discussions to more helpful than others when using clickers. For instance, one student reported that it was "helpful to hear why a certain answer was 'wrong' and to reason out the questions with instructor and classmates." This suggests that discussion focused on higher order processing may be more productive for students than discussions reiterating facts. It may also be that discussions enhance learning by facilitating interaction, which has been identified by other researchers as a possible causal mechanism for why clickers improve learning (Blasco-Arcas et al.,

2013). For instructors who may not regularly use interactive teaching methods, clickers may contribute to more observable changes in student discussion and learning. Only two of the four classes in this study had exams, so the data concerning students' opinions on the use of clickers for exam preparation may not generalize beyond those particular cohorts.

With regard to student engagement, the majority of students reported that clickers made the class more engaging than others. Given this study included two different courses in terms of curricula, it suggests that the utility of clickers for increasing engagement may be broad and independent of course content. This finding may also be particularly useful for courses in which the course material/curriculum may make it more difficult to stimulate student engagement, attention, and class discussion. One student who was enrolled in the first author's research methods course commented that the clickers were helpful "because [they] changed the pace of class." An alternative interpretation of the data regarding engagement is that graduate students are already at a higher level of engagement due to the stage of their training and the significant investment required to complete graduate school, but a few students explicitly noted in their comments that the clickers did make their experience more engaging from other classes. For example, one student stated that it was "nice to see the direction of others in the class" because "not everyone speaks up" in classroom settings.

We believe a few findings are particularly relevant to informing the application of CRS in smaller sized graduate-level courses in psychology. First, students reported that the clicker questions improved their ability to apply concepts to practical examples. This finding is particularly important for instructors of graduate-level courses. At the graduate level, students must be able to think critically and apply concepts to practical examples. This specific use of clickers (i.e., to improve complex thinking processes) has been noted by other researchers as a promising area for further study in the application of classroom technology (Bartsch & Murphy, 2011; Campbell & Monk, 2015) and might be a valuable consideration for instructors who plan to incorporate clickers into their graduate-level courses. We also think it is worth noting that a few of the studies that have reported null findings for clicker use have used exams as the outcome variable (Anthis, 2011; Zayac, Ratkos, Frieder, & Paulk, 2016). It is possible that clickers have more utility when used to stimulate active learning and application as opposed to recall and comprehension. Second, even in relatively small classes, participants in this study reported that the clickers helped them check their understanding on concepts. Students who may be reluctant to ask questions about a challenging concept aloud can use the clickers as a way to gauge their understanding of the course material. One student remarked that using clickers "felt like a self check on knowledge because [I] wasn't being judged for answers." The experience of this instructor was similar to that articulated by Sevian and Robinson (2011) in that it was surprising how even in small classes, the instructor may not accurately be able to judge student comprehension of

material. In this study, the clickers appeared to increase class participation and encourage shy or anxious students to participate, so the feedback and assessment received in the moment was more comprehensive than what the instructor would have gathered without clickers.

Despite the encouraging findings of this study, the nature of our sample, and the longitudinal design, several limitations do exist in this study. First, the range of students in each class was 11 to 28, and therefore, these results may not generalize to smaller or larger classroom settings. Second, this study did not assess the direct impact of clicker use on test scores or course grades. However, student perceptions and self-reported engagement have been shown to predict better course performance (Blasco-Arcas et al., 2013), but we are unable to examine this association using the data we collected. In addition, in graduate school, grades and test performance may not be the best indicators of future success in the field, as at this level of training, we are most interested in ability to apply information learned in class to work in the field. A third limitation is that the present study assessed clickers in graduate-level courses only. Because the average age of the sample was about 30 years, the results of the present study may not be generalizable to undergraduate courses or a younger graduate student sample. Last, the stability of favorable attitudes across time points may indicate a demand characteristic of the study design, in that the more the instructor used the clickers, the more motivated the students were to respond favorably.

In summary, the results of this study support previous findings that clickers can improve student engagement and application of concepts, even when used in relatively small graduate-level classrooms. Taken in context with the broader literature on clickers, our findings also support the conclusion proposed by others (Fortner-Wood, Armistead, Marchand, & Morris, 2013; Jones et al., 2013; Landrum, 2015) that the effects of clickers are related to multiple aspects of a particular learning environment and therefore still have promise as a tool to enhance learning when used thoughtfully and within a cogent pedagogical approach. We propose several recommendations for further research. Our pilot study was not a true experiment as we did not use any control group. Further research on the impact of CRS on student engagement and learning should involve a control group to limit any extraneous variables that may influence data collection. In addition, the first author of this study experienced technical problems at the initial stage of implementation which likely impacted student attitudes negatively. Therefore, we suggest that instructors seek appropriate training prior to evaluating the impact of technology in their classrooms but they should not be deterred by initial challenges (as also recommended by Campbell & Monk, 2015). Last, future research examining the mechanisms by which student engagement may improve learning outcomes would also help us determine the best applications of clicker technology.

Declaration of Conflicting Interests

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