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Journal of Marketing Education 2010; 32; 93 originally published online Sep 8, 2009;
DOI: 10.1177/0273475309344806

Journal of Marketing Education
Volume 32 Number 1
April 2010 93-103

10.1177/0273475309344806
http://jmd.sagepub.com
hosted at
http://online.sagepub.com

Learning to Click

An Evaluation of the Personal Response System Clicker Technology in Introductory Marketing Courses

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The incorporation of personal response system (PRS) clickers into teaching pedagogy has created implications for teaching practice and student satisfaction. Using a current undergraduate business student population, the authors measure student attitudes and preferences and identify student performance outcomes relating to the use of PRS clickers. Study results validate the broad applicability of this technology by showing positive student attitudes, learning experiences, and the mitigation of barriers toward acceptance of this technology. Importantly, measures of student performance correlate to self-reported learning outcomes realized through using PRS clickers. The study also finds evidence that PRS clickers benefit those students who are frequently disadvantaged in the classroom. Specifically, students with a low need for cognition or facing cultural barriers are shown to have a better learning experience when using clicker technology. The article concludes with recommendations on applying PRS clicker technology to teaching practice and identifies areas for future investigation.

Keywords: *clickers; technology; cultural barriers; need for cognition; student satisfaction*

Motivation

To continue to maintain class interest, focus, and motivation, today's students expect more visually stimulating material and the integration of technology into their lessons (Smart, Kelley, & Conant, 1999). This crop of technology-savvy students encourages faculty members to be customer-responsive in the delivery of innovative, broadly appealing instruction. According to Celsi and Wolfinbarger (2002), Marketing professors, more than those of any other discipline, need to be in step with their "customers," or be student-focused, using technology to communicate with current student cohorts as well as staying up-to-date in the field of marketing. As marketing professors, we teach our students to think about creating organizations that are customer-focused; we must model that behavior, responding to the interests and needs of our customers. Indeed, today's education customers are technology savvy, expecting technological interactions in most aspects of their daily life.

Larger class sizes and more international students create ongoing challenges for instructors attempting to engage students in active classroom discussion. Although successful teaching involves interaction (Sharples, 2000), current classroom setups offer uneven opportunities for students to communicate with instructors, in addition to time limitations and inferior seating arrangements that further reduce the potential for classroom dialogue (Liu, Liang, Wang, & Chan, 2003). Diversity in student populations, including increasing numbers of nontraditional learners, has motivated institutions to develop new ways to connect. The use of interactive classroom technology appeals to the broader learning styles of a range of students (Egemen, Edwards, & Nirmalakhandan, 1998) and offers educators a way to meet differing needs. As educators search for means to integrate teaching technologies within diverse student populations, such technology must be used as an integrating medium to facilitate student–instructor interaction and learning (Norman, 1990, 1994) but must also be meaningfully integrated into the curriculum to have positive learning outcomes (Zeon et al., 1999).

Interactive classroom technologies, specifically wireless handheld response units, deliver positive student attitudes toward learning (Simpson & Oliver, 2007), demonstrating that the incorporation of personal response system (PRS) clicker technology presents universities with a viable means to meet current customer demands.[1] This article builds on this initial research by showing that PRS clicker technology delivers positive learning outcomes across a broad variety of students with different learning styles, finding particular benefits for specific student populations. Importantly, it shows that the learning benefits realized are recognized not just in student attitudes but also in performance outcomes.

The article also identifies whether barriers to acceptance (i.e., frivolity, intrusiveness, cost) still exist and provides guidance on usage and application of PRS technology.

Our Contribution

The purpose of this article is to integrate and extend the previous work on interactive classroom technologies in four ways. First, using a current undergraduate business student population, this article validates the broad applicability of the technology by investigating the effects of PRS clicker technology on student attitudes and learning outcomes. Second, this article provides evidence that PRS clicker technology benefits those students who are frequently disadvantaged in the classroom. Specifically, students with a low need for cognition or facing cultural barriers are shown to have a better learning experience when using clicker technology. Third, this article identifies and tests for current barriers to acceptance of this teaching technology. Finally, this article offers a rationale for using the technology and suggests best practices for integrating the PRS clickers into course curriculums.

Interactive Classroom Technology

The use of technology in university classrooms is relatively recent but has advanced quickly. Advancements in technology to support teaching include Internet connections and video streaming, digital projectors, SMART boards and electronic collaboration platforms, PowerPoint and other presentation software tools, as well as a host of new software and online opportunities. A relative newcomer to classroom teaching technologies is personal response systems, or clicker, technology, also known as electronic voting systems and interactive response systems. In their summary of personal response system research, Simpson and Oliver (2007) conclude that although its use is more prevalent in science and engineering disciplines, the technology is increasingly being used in other subjects such as statistics and law. Implementation of the systems was primarily to manage interactions with large classes, ranging from 50 to 300 students, predominantly because of the perceived benefits of increasing interactivity within a large group.

Simpson and Oliver's summary (2007) concludes that students were broadly positive about the technology and were generally, although not universally, enthusiastic (Draper & Brown, 2002). Students appreciated that PRS clickers made classes more interesting and better organized, allowing them to better focus on areas of weakness without exposing their weaknesses to a group. Later studies revealed that students perceived themselves to have experienced deeper learning by using PRS clickers, and their critical thinking had been facilitated by the system (Williams, 2003).

Several perceived disadvantages were also identified (Draper & Brown, 2002), with students focusing on the intrusiveness of the technology, their concerns about how seriously other students would treat the work, and whether the technology was being used for its own sake.

In a preliminary study of interactive classroom technology, the use of PRS clicker technology was found to increase student participation and discussion, student enjoyment of the learning process, and to contribute to higher test achievement (Ueltschy, 2001). These findings corroborate similar research by Horowitz and Barrowy (1994), Marien (1995), and Slough and Lane (1995). The benefits of using the technology, as found by previous studies and summarized by Ueltschy (2001), have shown interactive technology to be useful in

- Maximizing class attention by offering visual and physical stimuli
- Increasing student participation and comprehension
- Offering immediate feedback between instructor and students and among students themselves
- Improving student recall
- Increasing student attentiveness
- Improving test scores (because of increased attentiveness, comprehension, and participation)
- Increasing student enjoyment of learning

Our research builds on the initial work described above, using a business student population, to assess current student attitudes toward this type of teaching technology, determine where it has specific advantages, and to identify best practices in its implementation.

Study Description

Technology Description

The interactive technology used in this study, Interwrite PRS® clickers (or PRS clickers) was supplied by eInstruction Corporation (see Figure 1). The PRS clicker system refers to a system in which students use individual wireless, handheld keypads (operating on infra-red technology) combined with a base station receiver, computer, and projection system (standard classroom computer technology). Students were required to purchase their own handheld PRS clicker as part of the course requirement (at a net cost of approximately $25). The instructor used simple editing software (downloaded from the Interwrite Web site) to create questions either for use embedded in a PowerPoint presentation or stand-alone. The instructor could choose any combination of the following question types: multiple choice, true–false, fill in the blank (students use the key pad to type an answer), or calculated responses.

Figure 1
PRS Clicker and RF-USB Receiver

Note: PRS = personal response system; RF-USB = radio frequency–universal serial bus.

The instructor sets each embedded question to poll student responses for a certain time period, for example, 30 s. The results are immediately displayed in graphical format within the PowerPoint presentation showing a histogram of student responses with the correct answer highlighted. The instructor can use the response histogram to invite the class to discuss the correct and, importantly, incorrect responses. Both the students and the instructor benefit by receiving immediate feedback on whether more instruction is needed about a particular concept or skill.

The system can also be used to administer quizzes (using student identifications), by automatically grading the responses and recording grades on each student's profile. This feature conserves class and instructor time as a result of instantaneous marking and recording as well as the immediate display of correct answers for each quiz question, again giving students immediate and meaningful feedback on their understanding of a concept. Instructors are able to offer regular class quizzes because of the reduced time required for grading and recording. This encourages students to keep up with class work and reading. Students profit by the use of regular quizzes, both through the encouragement to remain current in their coursework and how the instructor uses the in-class questions to signal exam expectations.

The instructor has the ability to track individual student responses (and attendance or, possibly, in a larger class, the attendance of the clicker) or allow the students anonymity (with question responses). Offering students the opportunity to respond to questions anonymously, as was done routinely during this course, promoted student contributions to class discussion, as is confirmed by other studies (Draper & Brown, 2002). Survey capability also exists should the instructor need to poll student opinions or demographics, either for in-class purposes or instructor use.

Method

The PRS clicker technology was used at a large Canadian university as one of the instructional techniques across two sections of a required undergraduate Introductory Marketing course. The total number of students using the technology was 93, all at an undergraduate level, relatively evenly divided between gender and primarily 3rd-year students. See Table 1 for a demographic breakdown of the sample. Students were surveyed on their final day of classes after using the technology for the duration of the school term.

An evaluation instrument was developed incorporating items from factors identified as pertinent to determining student attitudes regarding PRS clicker use. Students were asked to rate their agreement to a number of statements on 5-point Likert-type scales (*strongly disagree–strongly agree*). Attitude

Table 1
Key Dependent Variables by Demographic Breakout (n = 93)

	Satisfy Index	Learn Index	Participate Index	Time Barrier	Skepticism Barrier	Cost Barrier
Gender						
Male (n = 49)	3.82	3.74	3.48	3.63	2.27	3.04
Female (n = 44)	3.76	3.90	3.55	3.49	2.41	2.86
Business major						
Finance (n = 25)	3.93	3.97	3.67	3.60	2.23	3.00
Accounting (n = 32)	3.74	3.66	3.22	3.53	2.30	3.10
Marketing (n = 13)	4.10	4.12	3.74	3.88	2.31	3.00
Other (n = 23)	3.52	3.70	3.61	3.37	2.50	2.70
Year in program						
2nd year (n = 6)	4.11	4.00	4.30	3.58	2.50	3.33
3rd year (n = 72)	3.71	3.72	3.44	3.50	2.39	2.83
4th year (n = 12)	4.14	4.25	3.42	3.79	2.08	3.50
Culture						
Canadian (n = 31)	3.73	3.74	3.25_a	3.58	2.31	3.03
Non-Canadian (n = 61)	3.80	3.83	3.64_a	3.52	2.37	2.89
Learning style						
Concrete experience (n = 29)	3.84	3.97	3.62	3.78	2.26	2.86
Reflective evaluation (n = 12)	3.72	3.48	3.17	3.64	2.79	3.09
Abstract conceptualize (n = 23)	3.71	3.86	3.62	3.43	2.23	3.00
Active experiment (n = 16)	3.77	3.63	3.31	3.38	2.28	2.94

Note: All dependent variables are measured on 5-point Likert-type scales. Subscript a marks a p-value difference of p <.05.

measures included satisfaction with the technology (three items, α = .88), evaluation of the learning experience (four items, α = .90), and perceived level of participation in the class (three items, α = .73). Exploratory factor analysis with varimax rotation showed three distinct constructs accounting for 75% of the variance, with all items loading as expected. See the appendix for a full delineation of the scale items measured.

Individual differences including gender, business major, year in the program, self-reported overall grade-point average, cultural background, need for cognition, and learning style. To assess need for cognition, participants rated their agreement to statements (Cacioppo & Petty, 1982; Epstein, Pacini, Denes-Raj, & Heier, 1996) such as "Learning new ways to think doesn't excite me much" and "Thinking is not my idea of fun" (5-point Likert-type scales, three items, α =.72). These questions were used to evaluate the extent to which a student enjoyed engaging in effortful, cognitive activities. As Sadowski and Gulgoz (1996) demonstrated, students with a high need for cognition tend to achieve more academically. Learning style was assessed using Kolb's (1981, 1984) Learning Preference Inventory, where students identified their learning preferences in one of the four inventory classifications, that is, concrete experience, reflective observation, abstract conceptualization, and active experimentation. Each student's end-of-term grade in the Introductory Marketing course was also recorded.

Next, participants were asked their perceptions of barriers to PRS clicker technology adoption. We assessed concerns involving time required to learn or for class learning (two items, r = .61), possible skepticism toward the technology (two items, r = .63), and concerns over the cost of technology adoption (one item). We also investigated student recommendations regarding how PRS clicker technology should effectively be used in the classroom, that is, when questions should be asked, level of question difficulty, and the optimal number of questions used when the technology is incorporated into the class.

Finally, an open response question was related asking respondents if they had any general comments they wished to make regarding the technology. We tabulated the number of supportive versus unsupportive comments we received on our survey. Overall, more student comments (54) were encouraging about the clickers as compared to negative comments (19). We use these comments to add understanding to our quantitative results reported below.

Study Results

Attitude Measures: Positive Student Attitudes to PRS Clickers

In general, PRS clicker technology was broadly perceived by the students as increasing their satisfaction with this course (Introductory Marketing) as well as their perception of learning.

The mean for the overall satisfaction measure was 3.79, which was significantly higher than the scale midpoint,

$t(92) = 9.17$, $p < .001$. This shows that the technology was broadly appreciated by the students, demonstrating that students enjoy learning with PRS clicker technology. In parallel, the rating for the learning experience result was 3.81, which was also significantly higher than the midpoint, $t(92) = 9.26$, $p < .001$. This result indicates that student perceptions of learning with PRS technology was positive, suggesting that the incorporation of the technology into the classroom will facilitate positive learning outcomes. Supporting the scale rating findings, open responses from participants showed satisfaction with the use of clicker technology in the classroom. For example, "They were good for helping me learn the material and I think they are a very good method for helping students to learn in different ways!"Another student indicated, "It was a good experience and the clicker quizzes were SO helpful. It forced me to study . . . every week, which was great for the midterm."

The measures of class participation showed students perceived an increase in their participation in class discussion and their level of comfort in contributing to the discussion because of the use of PRS clickers. The mean ratings on the participation index was 3.51, again significantly higher than the midpoint, $t(91) = 5.68$, $p < .001$. Students voiced their increased perception of their participation using clickers as follows: "Cool way to engage students and promote discussion," "It draws me back after I 'zone-out,'" "Class attendance increased. Involvement increased."

Individual Differences and PRS Clickers: Universal Applicability and Benefits for the Disadvantaged

Several different individual difference variables, including gender, Business major, and year in the program were tested against student attitudes for learning with PRS clickers. No differences were observed in the cohort's preferences for PRS clickers across individual difference variables, demonstrating that this classroom technology is inclusive across a student population. Table 1 provides means and statistics for these comparisons.

Importantly, PRS clickers were shown to provide specific benefits to students who are often disadvantaged in a typical classroom setting. First, the study results show that students not born in Canada found that using PRS clickers enhanced their level of comfort in participating in class discussion more so than students born in Canada; non-Canadian mean = 3.64, Canadian mean = 3.25, $t(90) = 2.08$, $p < .05$. By using the clickers, we can surmise that students from non-Canadian cultural backgrounds felt more at ease participating in the dialogue following clicker questions. One non-Canadian student shared the following perception of his experience with us: "The clickers are really good since they increase my participation. I know I understand the lecture."

Second, the need for cognition index was shown to be significantly correlated with the student ratings for learning with PRS clickers, $r(92) = .21$, $p < .05$. This relationship indicates that students who do not enjoy thinking and deeply cognitive activities responded well to learning with the PRS clicker technology. Indeed, they found learning with clickers to be effective and useful. This finding is important because it validates this technology as a valuable methodology to facilitate learning with students who typically do not enjoy more traditional methods inherent in a university learning environment. Sadowski and Gulgoz (1996) suggest that students can be trained in elaborative processing and thereby increase academic performance. Our findings suggest that clickers may be an effective way to assist students in this regard.

Performance Outcomes

Conclusive evaluation of PRS clicker technology required objective analysis that could validate student perceptions of learning. To this end we used correlation analysis to assess student self-reported ratings of learning with actual grades achieved in the Introductory Marketing course. A significant positive correlation was identified, $r(90) = .21$, $p < .05$. This relationship verified that students who recognized learning benefits through the use of PRS clicker technology did in fact perform better in the course. Importantly, a significant relationship was not identified between ratings of learning with PRS clicker technology and the self-reported grade point average of the students. It seems the benefits identified with learning through the technology were specific only to the grade achieved in the Introductory Marketing course.

PRS Clickers and Kolb's Learning Styles

The students investigated in this study were classified, based on Kolb's Learning Preferences Inventory (1981, 1984), into one of four learning styles. The cohort's learning preferences are broadly distributed across learning styles, with slight preferences for concrete learning experiences and abstract conceptualization (see Table 1). Differences between learning styles did not account for variation in students' preferences toward PRS clickers and a null effect was observed. We can conclude that student attitudes toward PRS clickers do not depend on their preferred learning style. The lack of significant relationships here may suggest, as Young, Klemz, and Murphy (2003) found, that students view technology simply as a tool that is involved in implementing an instructional approach. Our students seemed to appreciate the clickers with respect to their different learning styles, as noted by one student: "I think they are a good method for helping students to learn in different ways!"

Barriers to Use: Changes in Student Attitudes

A student expressed his opinion on barriers to use as follows:

> At first I was upset and thought it was a waste but I enjoyed using them and think they are a great teaching tool.

The time necessary for technology adoption was not seen as a barrier by the majority of the student sample. The mean for this test was 3.56, $t(92) = 6.24$, $p < .001$, significantly above the scale midpoint. The time taken to learn how to use clickers, as well as for the class to learn, was perceived to be worthwhile in terms of overall learning. However, we did note negative commentary from a few students on this issue: "At times it took up too much time and they were too fussy." Our index capturing students' potential skepticism over the PRS clicker technology was shown to be significantly below the midpoint; mean = 2.33, $t(92) = 2.67$, $p < .001$. Students do not think that the PRS clickers are a gimmick or that the instructor is implementing technology without purpose, thereby indicating that this barrier to acceptance is not a significant concern for students. Indeed, the barriers previously identified around technology intrusiveness and frivolity (Simpson & Oliver, 2007) as concerns for students appear to have been mitigated or resolved as the technology gains more mainstream acceptance.

We also measured whether students perceived the financial expense of using this technology to be a potential barrier to acceptance. On average, students were neither inclined to agree nor disagree that the clicker technology expense was an issue (mean = 2.96, $t < 1$). The frequency distribution in response to this question showed a normalized pattern. Some students indicated the cost was not a factor: "They helped my learning so much. Worth the money I paid for the clicker. Now I think Marketing is awesome." Whereas other students indicated negative feelings toward the financial cost of purchasing the PRS clickers: "Not worth the $25 the Bookstore charges," "I thought the price of them was too much, especially considering I only used it for one class," and "The only thing I have against it is the cost . . . the clickers have very complex functions that we do not need. Can't we buy cheaper versions?" In fact, the majority of negative comments recorded focused on the issue of PRS clicker costs.

Suggested Best Practices: Student Opinions on Effective Technology Usage

The students were first asked how frequently they preferred to answer clicker questions during class, that is, several times during class or all at the end. There was a marked preference for questions being offered several times during class (see Figure 2). Intuitively and pedagogically this makes sense, as it offers an opportunity for the instructor to divide the class time into smaller sections emphasizing the learning in each portion by the use of clicker questions. Students valued the prospect of challenging and reinforcing their understanding multiple times during the 80-min class.

We asked the students whether they preferred clicker questions that were more difficult and thought provoking. There was often discussion, following a clicker question, that it had been too easy, with students favoring more challenging questions. This anecdotal evidence was supported by student responses in the survey. As shown in Figure 3, a strong majority of students indicated they preferred more difficult questions during class, where an ensuing discussion offers an opportunity to clarify the details of the question. Students voiced their preferences regarding question difficulty in the following ways: "I . . . prefer more thought-provoking questions that can give rise to more discussion afterwards," "Questions should be more challenging. . . . I prefer them not being for marks," and "Some of the clicker questions were too easy."

Finally, we asked students for their perception of the optimal number of clicker questions during an 80-min class. The majority of the sample (58%) indicated that an ideal number of questions to include would be five to seven, with a further cluster of respondents (26%) indicating two to four questions would be ideal. Figure 4 provides the frequency pattern of responses to this question.

General Discussion

Benefits of PRS Clicker Technology

Student. As demonstrated by the results of our study, students enjoyed using the PRS clicker technology in the classroom and reported benefits with respect to learning and participation within the class environment. This general validation of the technology was identified across learning styles and a number of demographic variables. Importantly, this self-reported improveme nt in learning was correlated to actual performance in the class. Students who found the PRS clickers useful in their learning experience scored higher grades than their contemporaries. This relationship did not extend to overall academic performance, providing some reassurance on direction of causality in the relationship observed.

Perhaps one of the most important student benefits identified through this research is the identification of positive implications of PRS clickers for disadvantaged students. International students found that the clicker technology facilitated their ability to participate in class. It seems the clickers provided an impetus and rationale for students to

Figure 2
Preference for Questions During Class Versus at End

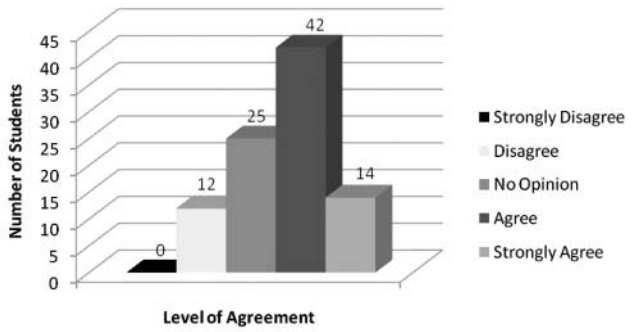
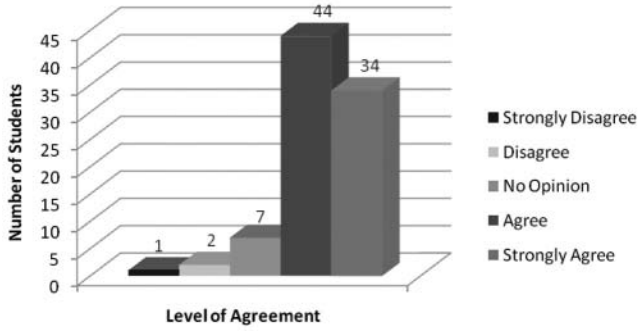


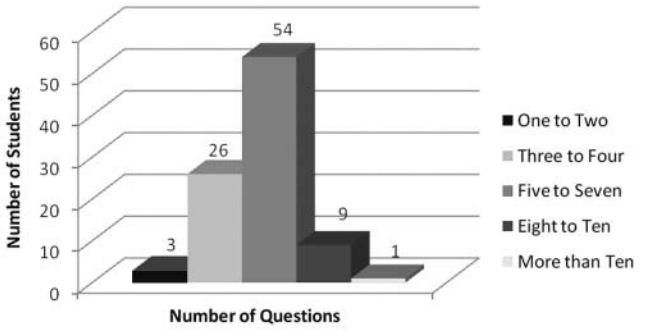
Figure 3
Questions Should Be Harder and More Thought Provoking



overcome cultural barriers that limit the likelihood of participation. Furthermore, students who identified themselves as low in need for cognition found that PRS clickers enhanced their learning experience more so than students reporting a higher need for cognition. This result shows a strong benefit of PRS clickers, namely, that they resonate with students who have difficulty getting excited about learning. This technology provides a "hand up" to those students who find the typical university classroom a challenging environment to navigate.

A possible explanation for student enjoyment of (learning with) PRS clickers is the immediate feedback received as to the accuracy of their answer to clicker questions posed during lectures. Students were able to instantly assess whether their answer was correct and determine their own level of comprehension on the topic of discussion. Previous research has also shown that technology-supported discussion methods lead to improvements in students' conceptual understanding and examination performance (Crouch & Mazur,

Figure 4
Optimal Number of Questions



2001; Dufresne, Leonard, & Wenk, 1996). Class discussion, as provoked by clicker questions, forces students to analyze and explain their answers to their peers with differing perspectives, resulting in more robust and elaborate mental construction of concepts than traditional lecture-based approaches.

Enhanced engagement is another benefit cited in previous research and observed qualitatively in our study. Boyle and Nicol (2003) showed that students reported enhanced engagement when they received histogram feedback, giving them more confidence and willingness to participate in class and peer discussions. Instructors noted that student attendance was high during clicker classes, activity levels in the class were high, and the students were animated, all of which suggest that student engagement is increased through the use of this teaching technology. This is consistent with the results of our study, statistically and anecdotally.

A further noted benefit to students is the development of a broader community within the classroom. As the sole class participating in learning with PRS clickers in the faculty, the class had a unique experience to discuss. Also, as the term progressed and the students became more comfortable in class discussion and realized how regular and consistent discussion would be with the clicker questions, the class became increasingly vocal, challenging each other and offering varying points of view.

Instructor. Increased class participation and more active discussion is a positive benefit of implementing this technology into classroom practice. Once committed to a response, students were more willing to discuss their answer (Crouch & Mazur, 2001). Furthermore, students who were less likely to participate in an unstructured discussion were more comfortable defending their answer choice. By having committed to an answer, the students tended to be more engaged in the discussion of the question and will continue to work out an answer if they are required to input it into the PRS clicker. Overall, the system encourages most students to

participate. This is rewarding for an instructor as the class is more engaged and actively involved in learning.

The most significant learning gains come from the more immediate feedback between student and instructor, allowing the instructor to better align the delivery and to teach by the method of questions (Simpson & Oliver, 2007). By offering more opportunities for an information flow that is two-way (instead of one-way) in the classroom, instructors are more easily able to identify when students are experiencing difficulty (Boyle & Nicol, 2003). By being more in sync with students' understanding of the conceptual material being presented, instructors are able to adapt their instruction in response (Boyle & Nicol, 2003). Instructors, starting with well-designed questions, encourage students to think beyond their initial understanding (or lack thereof) of the material and expand further. A richer, more fulfilling classroom dialogue ensues. By working more active learning into classroom activities, students are more likely to feel engaged and supported (Martin, 1999) and more satisfied with their learning experience in the course.

Institution. As Boyle and Nicol (2003) noted, many universities are challenged by classes with large enrollments, a trend that dictates against discussion and student engagement. As this development is unlikely to diminish, institutions must look for ways to keep students engaged and make classes interactive. The use of PRS clicker technology offers institutions opportunities to address these concerns.

Institutions may be able to improve weak conceptual understanding, improve insufficient interaction between instructors and students and improve student motivation (Boyle & Nicol, 2003) through the use of clicker technology. Institutions may also find that the implementation of clicker technology offers a technique to bridge cultural gaps with foreign students, better addressing their learning needs. As student populations become increasingly global, institutions must be able to respond to cross-cultural barriers in the classroom.

Barriers to Use

Our findings indicate that previously identified barriers to student acceptance of PRS clicker technology (Simpson & Oliver, 2007) have largely been mitigated. Students do not see this technology as a gimmick but as a positive learning methodology. Furthermore, the time required in technological adoption appears to be acceptable to students and they see value in the time invested. Our question regarding financial cost shows some ambivalence in our student population. Most students did not perceive the expense incurred to be a large barrier in using the technology; however, our sample did not fully endorse the costs incurred when evaluating the technology.

Perhaps the most significant cost in implementing PRS clicker technology is the change required in the instructor teaching model. The increased time needed to prepare lectures, from restructuring the lecture's flow to creating appropriate questions, is significant. To adequately integrate the PRS clickers into teaching pedagogy, instructors must adapt their classroom delivery to cover less material. Creating time within the class period, and within the course material, for questions, requires discipline by the instructor in developing the course content. Understanding that discussion about a concept will often become broader than just the concept being taught should be incorporated into lecture planning. Pre-class planning needs time to develop good questions that are relevant to the content of the day's work as well as appropriately difficult. A significant challenge is creating questions that are pitched at the appropriate level (Draper & Brown, 2002). Instructors using this technology however are prone to be innovators or visionaries within their faculties and are likely to be willing to spend time learning about the technology and adapt their lectures. It is critical for instructors to remember, however, that PRS clickers are a teaching tool only, not a teaching approach. When the clickers are used to support active engagement within the classroom environment, there is evidence that students' motivation and attentiveness increases. This may be due, in part, to the necessity for the instructor to stop lecturing and rethink teaching, reducing the breadth of coverage of a topic.

There is also the need for development of staff skill for implementing PRS clicker systems, as has been highlighted in previous literature (Simpson & Oliver, 2007). This has been augmented with the recognition that technical skill needs to be supplemented with contingent teaching so that instructors can respond to the immediate feedback and teaching opportunities that arise (Dufresne et al., 1996).

Best Practices: Integrating PRS Clicker Technology Into Instructional Methods

The implementation of PRS clicker technology as a classroom technology represents an example of discontinuous innovation in teaching and is a fundamental change in how students and instructors interact. According to Celsi and Wolfinbarger's model (2002), the integration of this type of technology falls within the general "wave" of change of discontinuous innovation, ultimately resulting in a change in the behavior within the classroom and of what the classroom is. As the students become more aware of their ability to discuss with each other, and view the instructor as a facilitator, the behavioral expectation shifts from passive, lecture-based teaching to active and participatory learning. Celsi and Wolfinbarger also suggest that discontinuous innovation creates stronger relationships with students and enables achievement of learning goals.

Several themes evolve in a survey of the previous research in terms of practical tips for best practices in teaching and learning with clicker technology. The prior research relevant to this study can be used to provide practical suggestions in three areas: interaction and discussion, question preparation, and changes to the depth of course material.

Boyle and Nicol (2003) investigated the importance of interaction and discussion when using clicker technology and concluded that peer discussion was central to this teaching method as it engaged students actively in learning. It is important that during class discussion, the instructor ask students for detailed reasoning behind their clicker answers. Classwide discussion was also found to be important in offering the instructors an opportunity to understand why students got the wrong answer, check assumptions that students were making in formulating answers, and understanding difficulties with question comprehension (Boyle & Nicol, 2003).

The construction of effective questions is critical to the success of teaching with clickers (Boyle & Nicol, 2003). Instead of organizing a lecture around a presentation, class time should be organized around key concepts and the development of concept questions. Instructors need to focus on understanding what is difficult for students to understand about a concept and devise questions that focus on this difficulty. There is a potential, as Boyle and Nicol (2003) note, to categorize questions using Bloom's (1956) taxonomy (knowledge, comprehension, application, analysis, synthesis, evaluation) so that as the class and course progress, the level of difficulty of the questions also does. Creating a spread of correct versus incorrect answers is also important in devising good clicker questions (Boyle & Nicol, 2003) to trigger valuable class discussion. Another finding from prior literature (Cutts, Carbone, & van Haaster, 2004) recommends that when a question is answered mostly correct by the class, the instructor should move on to further instruction and not use the whole class's time on remediation.

Finally, previous research points to the importance of whether instructors can "cover as much material" in class using clicker technology and concludes that teaching around concepts may reduce or increase the input depending on student responses to clicker questions (Boyle & Nicol, 2003). Our experience is that the breadth of material covered during the course decreases with the benefit of depth of coverage increasing.

Our results point to practical recommendations that can enhance the effectiveness of PRS clicker usage in the classroom. Clearly, this technology needs to be incorporated throughout the body of the lecture discussion. It appears the benefits that accrue to this methodology, such as improved discussion and learning, are best realized when questioning using clickers is interspersed among course content. Our findings also point to the necessity of effectively gauging question difficulty for the class. Calibrating clicker questions to challenge students seems to be an advised approach. The nature of this technology, that is, the anonymity and security it provides students, makes it an excellent tool for challenging students with advanced material and concepts. Finally, we can recommend that it is important to not go overboard in applying this technology in the classroom. Our sample indicated an ideal number of questions ranging between five and seven, which shows perhaps that "less is more" when implementing this approach.

Limitations and Future Research

Our research has a number of limitations. First, the data collection was conducted at the end of the semester when students perhaps had a sense of what their grade outcome would be. This could have biased student perceptions of the PRS clicker technology. Second, our research is descriptive in nature and lacks comparison to a control sample that did not use clickers. Furthermore, the questions used in our survey instrument did not provide an effective comparison point. Third, some of the questions articulated may have biased students in their response. Although the aggregation of scale items addresses this concern somewhat, the positive framing of some of our survey questions qualifies the findings. Each of these limitations seeds a number of opportunities for future investigations. For example, future research should assess the long-term learning implications of PRS clicker technology. A controlled longitudinal study that compares classes using the technology with classes that do not use the technology would be ideal. Learning and student development could be assessed through grade performance as well as participation and other individual growth variables. Conclusive evidence demonstrating that learning is enhanced through this technology would greatly facilitate adoption.

A second opportunity for future research is the ability of PRS clicker technology to merge and integrate with other classroom technologies. Technology advances in the classroom have provided instructors a myriad of teaching options. What combination of technology and approaches best facilitate student learning? Can PRS clickers bridge adoption for other new technologies? Furthermore, what opportunities will development of the PRS clicker technology provide? The current system provides limited response options. As the technology advances, more involved response will be possible and additional teaching features are likely to be added.

Finally, more research is needed in determining what format of classroom instruction and pedagogy best matches the PRS clicker system. Is this technology best suited to formal lecture classes or better applied to case-based teaching? Does the system work well in both large classes and smaller classes? What type of curriculum, for example,

Appendix
Scale Items Measured in Survey

Note: Student reactions were measured based on a 5-point scale where 1 = *strongly disagree*, 2 = *disagree*, 3 = *no opinion*, 4 = *agree*, 5 = *strongly agree*.

Overall satisfaction was measured (aggregate) by

1. I liked using PRS clickers in my Introduction to Marketing class.
2. I believe that by using PRS clickers, my enjoyment in learning about Marketing increased.
3. I found that this class was more fun because I used a PRS clicker.

Learning was measured (aggregate) by

1. I believe that by using PRS clickers, I learned more about Marketing than I would have without using clickers.
2. I believe that I learned more about Marketing by using PRS clickers because I was able to answer questions during the lecture.
3. I believe that I learned more about Marketing by using PRS clickers because the questions I responded to during the lecture pushed my level of understanding deeper.
4. The clicker questions presented during the lecture increased my understanding of the material.

Class participation was measured (aggregate) by

1. I found it easier to participate in this class because I knew what other students understood (based on their clicker responses on the graph).
2. I participated more in this class because I was using a clicker.
3. Using the clickers increased my level of comfort in participating in class discussions.

Barriers to acceptance were measured by

1. The time it took me to learn how to use the clicker and feel comfortable with the technology was worth it in terms of the benefits I received. (time item)
2. The extra time that it took the whole class to learn how to use the clickers was worth it in terms of the benefits. (time item)
3. PRS clickers seemed like a gimmick. (skepticism item)
4. I believe that the instructor should stop fooling around with technology and just teach the material. (skepticism item)
5. The expense of the clicker was worth it based on the benefits I received. (cost item)

Preferences for best practices were measured by

1. The clicker questions presented during the lecture should be more thought provoking to increase my learning
2. I prefer when clicker questions were offered several times during the lecture versus all at the end.
3. The optimum number of clicker questions during an 80-min lecture is:
   1-2 3-4 5-7 8-10 >10

marketing research or consumer behavior, best fits the use of clicker activities? Our research validates the use of PRS clicker technology in marketing education and we hope provides the impetus for additional investigation in the area.

Note

1. The interactive classroom technology referred to in this article is a system in which students use personal wireless keypads in conjunction with a base station and instructor software. The system is otherwise known as PRS clicker technology or PRS clickers.

Acknowledgment

We acknowledge the helpful comments from two anonymous reviewers and Doug Lincoln (the editor).

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