Just-in-Time or Plenty-of-Time Teaching? Different Electronic Feedback Devices and Their Effect on Student Engagement

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ABSTRACT
This study examines how incorporating different electronic feedback devices (i.e., clickers versus web-based polling) may affect specific types of student engagement (i.e., behavioral, emotional, and cognitive engagement), whether students’ self-efficacy for learning and performance may differ between courses that have integrated clickers and those that use web-based polling, and whether using web-based polling influences faculty members’ instructional practices. The participants included six instructors and 209 students enrolled in classes at a university in the southwestern United States in which the instructors used either clickers or web-based polling. The Plenty-of-Time Teaching (PoTT) and the Just-in-Time Teaching (JiTT) approaches and their implications are presented. The results of this study highlight the benefits of using various types of electronic feedback devices to provide innovative ways to implement JiTT or PoTT, such as gauging students’ understanding with pre-class polls, and offer insights that can benefit educators who wish to promote students’ emotional and cognitive engagement with various types of feedback devices.

Keywords
Electronic feedback device, Polling, Just-in-time teaching, Engagement

Introduction

One main problem with the traditional lecture format is that students’ levels of engagement tend to be low, which may cause their learning to suffer. In the past five years, technology has started to be applied in lecture halls and in online settings to address this issue (Delialioğlu, 2012; Koenig, 2010; Mason, 2011; Middlebrook & Sun, 2013; Sun & Rueda, 2012; Walsh, Sun, & Riconscente, 2011). Specifically, the use of electronic feedback devices (also called electronic voting systems or clickers, herein called “clickers”) is becoming more common in academic settings, especially at higher education levels (Gilbert, 2005; Martyn, 2007).

However, one limitation of clickers is that the instructors can only conduct polling during lectures, as the connection of the device is based on a live session. In addition, students can poll their answers from only one medium (i.e., the "clickers"). With web-based polling (e.g., PollEverywhere.com), students may respond before, during, and after a lecture via various devices, such as text messages, as well as mobile, desktop, and laptop browsers, which provides flexibility for instructors who want to integrate different pedagogies into the curriculum. For example, instructors can post questions on PollEverywhere.com prior to a class and modify the learning activities based on the results of the students’ polling responses.

Currently, there is a lack of research empirically investigating web-based polling and its possible benefits with regard to delayed feedback. Therefore, the current study sought to evaluate the effectiveness of clickers and web-based polling for providing delayed feedback from learners and to determine how incorporating different polling strategies (i.e., clickers versus web-based polling) may affect specific types of student engagement (i.e., behavioral, emotional, and cognitive engagement) (Fredricks, Blumenfeld, Friedel, & Paris, 2005; Fredricks, Blumenfeld, & Paris, 2004). The current study also investigated whether students’ self-efficacy for learning and performance differs between courses that have integrated clickers and those that use web-based polling and whether using web-based polling influences faculty members’ instructional practices.
Literature review and research model

Clickers and polling

One way of gaining immediate feedback during classroom instruction is to employ radio frequency-based electronic feedback devices (i.e., “clickers”) (Fortner-Wood, Armistead, Marchand, & Morris, 2013). Clickers are small, portable devices that use infrared or radio frequency technology to transmit and record students’ responses to questions. Clickers provide instantaneous feedback to both the instructor and the students about the level of understanding of the material being presented. The use of clickers has revealed a variety of benefits with regard to instructional goals and objectives; for example, the anonymity of the responses encourages the participation of students who may otherwise be reluctant to do so. The anonymous, simultaneous manner of gathering responses via clickers (in comparison to traditional hand-raising) eliminates students’ tendency to conform to the answers of the academically higher-status students (Kennedy & Cutts, 2005; Stowell & Nelson, 2007). The use of clickers has also encourages an increase in student engagement (Bode, Drane, Kolikant, & Schuller, 2009; Dallaire, 2011; Lasry, 2008; Stowell & Nelson, 2007; Trees & Jackson, 2007).

To date, studies examining the benefits of using electronic feedback devices have established a limited range of increases in academic performance (Anthis, 2011; Elicker & McConnell, 2011; Kennedy & Cutts, 2005; Stowell & Nelson, 2007). Kennedy and Cutts (2005) demonstrated that students who frequently used clickers in class could be categorized as either high or low performers and that the students who were low frequency clicker users clustered into moderate and low performers on in-class tests and end-of-term exams. Conversely, Stowell and Nelson (2007) found no differences in learning outcomes on class quizzes between learners who used clickers and those who responded with more traditional methods, such as response cards or hand raising.

Just-in-time teaching

Another benefit of electronic feedback devices has been its use with "Just in Time Teaching" (JiTT), given that the clickers facilitate the instructors’ ability to gain immediate feedback regarding what students know or do not know (Novak & Middendorf, 2004; Novak, Patterson, Gavrin, & Christian, 1999; Simkins & Maier, 2004). Given the immediacy of the aggregated responses, instructors can quickly ascertain which concepts need to be re-examined (Lasry, 2008). This teaching strategy was first developed to enhance students’ learning experiences by helping Physics faculty members learn which topics their students struggled with, and it has continued to be used in Physics (Crouch & Mazur, 2001) and in other domains, including Biology (Marrs & Novak, 2004) and Economics (Simkins & Maier, 2004). The following three core principals frame the JiTT approach: maximize the effectiveness of the class time discussion; make non-class time beneficial for students; and foster and perpetuate peer interactions. To facilitate these principals, Novak and colleagues (1999) suggest that web pages be used to house questions related to upcoming course content and that students submit their responses to these questions to the instructor a few hours before class. The latter element then manifests during class time when the instructor uses the feedback garnered from the out-of-class activities to develop a framework for the live class session. In this sense, the teaching occurs “just in time” in that students’ misconceptions, partial conceptions, or high levels of conception inform the instruction. The instructor might have planned to use a set lecture and series of learning activities that, unbeknownst to the instructor, were well beyond the students’ grasp, given their misunderstandings. Thus, delivering lectures that are based on the assumption that students understand the content actually perpetuates their misunderstandings or misconceptions. Conversely, students who possess a high level of understanding may disengage from a lecture and find the learning experience boring.

Plenty-of-time teaching and asynchronous polling

Although the immediacy of aggregated in-class responses helps instructors facilitate the JiTT strategy and quickly ascertain which concepts need to be re-examined (Lasry, 2008), one limitation of this approach is the lack of time available for an instructor to make quality adjustments to the content. One approach to mitigate this problem is the use of “Plenty-of-Time Teaching,” which is the purposeful use of pre-class activities, such as open-ended and multiple-choice questions, conducted via the Internet, that are aimed to engage students with the content prior to a class discussion. Given that students submit their responses a few hours before class, the instructor is able to modify
the content and learning activities based on the levels of students’ misunderstandings or misconceptions with the material (Novak et al., 1999).

Most studies have used open-ended questions to address the difficult problems presented in the text. For example, Crouch and Mazur (2001) typically posed three questions per unit with two question related to difficult aspects of the readings and one aimed at soliciting feedback about the overall difficulty of the concepts from the readings. Similar to this approach, two of the instructors who participated in Crouch and Mazur’s (2001) study used open-ended type questions, whereas the other three used forced response questions. However, unlike previous studies, these instructors solicited the students’ responses to the questions well before the class discussion, typically two to three days before, compared to a few hours before, as suggested by the aforementioned studies. Another consistent factor in this approach is the use of “in class” feedback through electronic polling. Bode et al. (2009), Crouch and Mazur (2001), and Lasry (2008) utilized in-class polling to gain insight into students’ understandings or misconceptions of the materials with regard to how they modified the content based on the pre-discussion feedback. Breaking from this traditional JiTT approach, the current study sought to examine how the use of web-based polling influenced instructors’ willingness to change lecture content based on data from pre-class polls. To date, no studies have examined whether the use of asynchronous pre-class polling influences an instructor’s willingness to change the class lecture or learning activities based on this feedback. To clarify, traditional clicker polls are administered in real time, or synchronously, by an instructor and with other students. The technological limitations dictate that these must be administered in a synchronous manner, such that both the students and the instructor are bound by time and place. Conversely, asynchronous administration is analogous to learning in which students and teachers are not bound by time or place. In this regard, web-based polling can be used both synchronously and asynchronously, with the purported advantage being that an instructor can obtain feedback on students’ understanding well in advance of the class discussion (as well as during and after the class discussion) with an asynchronous system. Therefore, the current study calls this strategy “Plenty of Time Teaching” (PoTT), in contrast to “Just-in-Time Teaching.” The specific focus of the current study was to examine whether the type of polling device used and the manner in which it was used significantly influence student engagement.

Student engagement

The notion of student engagement, particularly at the higher education level, has been examined in different capacities over the past 30 years. Astin (1984) initially described the notion of engagement as student involvement and defined it as the degree to which students expend both physical and psychological energies to achieve a particular task. Kuh (2009) similarly asserted that engagement is the amount of time and effort that students devote to achieving a desired task. Kuh (2009) also included the role that institutions play in fostering student engagement in his definition. From these two definitions, it is evident that engagement consists of both observable and unobservable characteristics. To better understand these two categories of characteristics, Fredricks and colleagues (2004) developed a framework in which engagement is comprised of the following three components: behavioral, emotional, and cognitive engagement. Behavioral engagement refers to an individual’s participation in school (Finn, 1993). Thus, behavioral engagement refers to what Astin (1984) and Kuh (2009) described as the time and effort spent on observable academic activities, such as studying, note-taking, participating in class discussions, and preparing for exams. Emotional engagement refers to an individual’s positive or negative feelings towards school (Finn & Voelkl, 1993; Fredricks et al., 2004). Although a learner may engage in observable behaviors that indicate a certain level of effort, the feelings a learner may have in relation to a certain learning activity may not readily be observable. Cognitive engagement refers to an individual’s voluntarily exertive effort to understand and master challenging tasks (Fredricks et al., 2004). Astin (1984) described this as psychological effort. Regardless of whether it is called cognitive or psychological engagement, neither is easily observed. Unlike behavioral or physical engagement and similar to emotional engagement, cognitive engagement is not easily observed, as it is essentially the degree to which a learner uses one or more cognitive processes to learn.

One way to address the problem regarding learners’ unobservable engagement characteristics is to use electronic feedback devices, which utilize questions intended to extrapolate learners’ levels of cognitive engagement, in addition to their behavioral and emotional levels of engagement. Existing studies investigating feedback devices have reported the benefits of increased overall engagement (Bode et al., 2009; Dallaire, 2011; Lasry, 2008; Stowell & Nelson, 2007; Trees & Jackson, 2007), but they have rarely examined the influence of using feedback devices on specific types of student engagement. Hence, this study aimed to determine how incorporating different devices (i.e.,
clickers versus web-based polling) affect the specific types of student engagement (i.e., behavioral, emotional, and cognitive engagement) identified by Fredricks and colleagues (2005; 2004). For the purposes of this study, engagement is defined as the extent to which a learner is cognitively, emotively, and behaviorally involved in or committed to a learning activity or goal.

Self-efficacy for learning and performance

Self-efficacy is defined as an individual’s beliefs about his or her abilities with regard to accomplishing a task. It is not concerned with the amount or quality of the skills one possesses, but rather with what a person believes he or she can achieve with the skills that he or she possesses (Bandura, 1977). Schunk and colleagues (2013) explained self-efficacy as “one’s perceived capabilities for learning or performing actions at designated levels” (p. 379). The current study examined the relationship between students’ self-efficacy with regard to learning a course’s content and their academic performance in that course. In other words, the researchers were interested in determining whether students over- or under-estimated their self-efficacy regarding the specific content of their courses, irrespective of the actual knowledge and skills that they possessed prior to and during their time enrolled in the courses. Specifically, the study examined whether there were differences between students’ perceived self-efficacy for the subject matter being taught and their ultimate performance based on the types of feedback devices used (i.e., clickers versus web-based polling).

Based on a review of previous literature regarding clickers, polling, JiTT, PoTT, student engagement, and self-efficacy for learning and performance, this study sought to examine how incorporating different electronic feedback devices (i.e., clickers versus web-based polling) may affect specific types of student engagement (i.e., behavioral, emotional, and cognitive engagement), whether students’ self-efficacy for learning and performance may differ between courses that have integrated clickers and those that use web-based polling, and whether using web-based polling influences faculty members’ instructional practices. A brief conceptual model of the current study is presented in Figure 1.

![Research model](image)

**Figure 1. Research model**

**Experimental design**

The current study utilized a quasi-experimental design. To capture differences between the effects of using clickers and web-based polling, data were collected from students enrolled in classes at a large research university in the southwestern U.S. The classes were as follows: (1) an educational psychology class in which the instructor used clickers during the lecture (the clicker group; control group) and (2) all other classes using Poll Everywhere.com (the web-based polling group; experimental group).
**Participants**

Of the 209 students who participated in the survey, 45.5% \( (n = 95) \) were in the clicker group, and 54.5% \( (n = 114) \) were in the web-based polling group. Female students \( (n = 128) \) represented 61.5% of the participants in this study. The mean age was 23.18 years \( (SD = 7.07) \). All students in the clicker group were undergraduates, whereas the majority of students (64.9%) in the web-based polling group were graduate students. Although this may be a limitation of the current study, given that class levels may influence the results, this effect was minimized by the university’s grading policy, which included standardized grading criteria. Additionally, the content of all of the classes in the experimental group was related to education (e.g., educational psychology, health education, and music education), and all of the instructors were full-time professors at the university with a doctorate in their field. All courses used a minimal amount of lecture material and emphasized student participation either via question-answer format or through planned small group or individual activities. Finally, the Levene’s statistic revealed that the significance values for the engagement subscales, for total engagement, and for self-efficacy were all greater than .1, indicating that the population variances in this study were equal.

**Treatments and instructional design**

Figure 2 presents the experimental design for this study. The instructor in the control group conducted in-class clicker activities to gain immediate feedback from the students. The instructors in the experimental (web-based polling) group were asked to post three to five questions on PollEverywhere.com six days before class each week to facilitate the possible effect of the PoTT strategy. Figure 3 presents a screenshot of web-based polling and its result. An example question is as follows: “Read the following goal: Universal Coffee employees will know how to make vanilla café lattes with 100% accuracy. Define the level of this goal.” When creating questions, instructors in both the control and experimental groups were encouraged to incorporate the four knowledge dimensions and six cognitive process dimensions that have been identified by Bloom’s Taxonomy Structure (Anderson & Krathwohl, 2001). The former includes (1) factual knowledge, (2) conceptual knowledge, (3) procedural knowledge, and (4) meta-cognitive knowledge, and the latter includes (1) remembering, (2) understanding, (3) applying, (4) analyzing, (5) evaluating, and (6) creating. The instructors in the experimental group re-poll the same or similar questions during their lectures to measure for differences in responses. Both the control and experimental groups’ instructors reviewed the polling answers (via clickers or PollEverywhere.com). If over 75% of students chose the correct answer, the instructors asked for a brief justification. However, if a significant portion of the class (more than 30% of the students) did not choose the correct answer, the instructor initiated a discussion to understand and address the students’ misconceptions. All activities were logged to measure the instructors’ success when revising the course content based on the polling data.

![Figure 2. Experimental design](image-url)
Survey data were collected from students in the eighth week of the semester via an online survey (for the education psychology class; the clicker group) and with a paper-and-pencil survey (for all other classes; the web-based polling group). The survey format (online or paper-and-pencil) was determined based on the participating instructors’ preferences. At the end of the semester, a focus group meeting was held with all of the participating instructors, and all of the participating students completed an anonymous open-ended questionnaire to further explore both faculty and students’ perspectives regarding how web-based polling influenced the level of instruction and to gauge all participants’ overall satisfaction with the quality of the two different types of electronic feedback devices.

![Figure 3. Screenshot showing web-based polling and its result](image)

Instrumentation

The instruments used in this study were adapted from existing validated scales as follows: the Self-Efficacy for Learning and Performance scale from the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia, & McKeachie, 1991) and the Engagement Scale (Fredricks, et al., 2005). The MSLQ was developed by the National Center for Research for Improving Postsecondary Teaching and Learning at the University of Michigan in 1986. The subscale called self-efficacy for learning and performance in this instrument was used to measure students’ self-efficacy in the context of the polling environment. Fredricks and colleagues (2005) developed the Engagement Scale to measure the following three types of engagement: behavioral engagement, emotional engagement, and cognitive engagement. Given that the Engagement Scale was designed to measure children’s levels of school engagement, some of the items had to be modified to measure the engagement levels of graduate and undergraduate students; for example, the item “I follow the rules at school” was revised to “I am compliant with the university’s standards of behavior.” All of these scales used a 6-point Likert rating (6 = strongly agree, 5 = agree, 4 = somewhat agree, 3 = somewhat disagree, 2 = disagree and 1 = strongly disagree).

The internal consistency coefficients (Cronbach’s $\alpha$) were computed to identify the reliability of the various scales. The results were as follows: .919 for the self-efficacy for learning and performance scale; .873 for the overall engagement scale; .519 for the behavioral engagement scale; .917 for the emotional engagement scale; and .840 for the cognitive engagement scale. Given that the internal consistency coefficient (Cronbach’s $\alpha$) of the behavioral engagement scale presented an unacceptable value ($\alpha = .519$), exploratory factor analysis was used to analyze the 19 items on the engagement scale to determine which items loaded onto which types of engagement. The results of the exploratory factor analysis revealed that two factors (emotional engagement and cognitive engagement) most distinctly described the variance in the data. Therefore, the behavioral engagement scale was dropped. As a result, two specific types of engagement (emotional and cognitive engagement) and overall engagement were included in the data analysis.
Results

Data analysis

All of the quantitative data were coded and prepared for computerized analysis using the Predictive Analytics Software (PASW) 17.0 program. Cronbach’s alpha was computed to validate the reliability of each measurement scale. For descriptive statistics, frequencies were computed for the nominal variables, and the means and standard deviations were computed for both the interval and nominal variables in the survey. Factor analysis was used to examine the 19 items of the engagement scale to determine which items loaded onto which types of engagement. Pearson correlation coefficients were computed to examine intercorrelations among the percentages of correct answers for the pre- and end-of-class polling questions and the percentages of the lectures that were modified by the instructors. Finally, t-tests were conducted to examine the differences in the means between the clicker and web-based polling groups.

Research question 1

Are there differences in emotional, cognitive, and overall engagement between courses that integrated the clickers and those that used web-based polling? Independent sample t-tests were conducted to determine whether there were significant differences in emotional, cognitive, and overall engagement between the clicker and the web-based polling groups. The results showed that there were significant differences in emotional engagement ($t(206) = -6.469, p < .001$), cognitive engagement ($t(207) = -6.214, p < .001$), and total engagement ($t(207) = -7.931, p < .001$) between the clicker and the web-based polling groups. Specifically, students in the web-based polling group had significantly higher levels of emotional engagement ($M = 4.60, SD = .986$), cognitive engagement ($M = 4.57, SD = .845$), and overall engagement ($M = 4.75, SD = .610$) than those in the clicker group ($M = 3.71, SD = .987; M = 3.86, SD = .778$; and $M = 4.08, SD = .599$, respectively). The results of the t-tests are presented in Table 1.

<table>
<thead>
<tr>
<th>Type of Engagement</th>
<th>Clicker M</th>
<th>SD</th>
<th>Web-Based M</th>
<th>SD</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotional Engagement</td>
<td>3.71</td>
<td>.987</td>
<td>4.60</td>
<td>.986</td>
<td>.000**</td>
</tr>
<tr>
<td>Cognitive Engagement</td>
<td>3.86</td>
<td>.778</td>
<td>4.57</td>
<td>.845</td>
<td>.000**</td>
</tr>
<tr>
<td>Overall Engagement</td>
<td>4.08</td>
<td>.599</td>
<td>4.75</td>
<td>.610</td>
<td>.000**</td>
</tr>
</tbody>
</table>

Note. Clicker = Students in the clicker group; Web-Based = Students in the web-based polling group.
*Significantly different at the .05 level.
**Significantly different at the .001 level.

Research question 2

Are there differences in students’ self-efficacy for learning and performance between the courses that integrated the clickers and those that used web-based polling? Independent sample t-tests were conducted to determine whether there was a significant difference in students’ self-efficacy for learning and performance between the clicker and the web-based polling groups. Contrary to expectations, students in the web-based polling group had lower levels of self-efficacy for learning and performance ($M = 5.02, SD = .813$) than those in the clicker group ($M = 5.26, SD = .586$). The results of the t-tests are presented in Table 2.

<table>
<thead>
<tr>
<th>Type of Engagement</th>
<th>Clicker M</th>
<th>SD</th>
<th>Web-Based M</th>
<th>SD</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Efficacy</td>
<td>5.26</td>
<td>.586</td>
<td>5.02</td>
<td>.813</td>
<td>.020*</td>
</tr>
</tbody>
</table>

Note. Clicker = Students in the clicker group; Web-Based = Students in the web-based polling group; Self-Efficacy = Students’ self-efficacy for learning and performance.
*Significantly different at the .05 level.
**Significantly different at the .001 level.
To better understand this result, additional t-tests were conducted to consider class standing as a possible contributing variable to students’ level of self-efficacy. The results showed that both within the web-based polling group and among all of the participants, undergraduate participants had significantly higher levels of self-efficacy for learning and performance than graduate participants ($t(111) = 2.863, p < .01$, and $t(206) = 3.989, p < .05$, respectively). Additionally, t-tests were conducted to assess whether there were differences in the levels of self-efficacy between the undergraduates who used clickers and those who used web-based polling. There were no significant differences ($t(132) = -.523, p = .602$).

**Research question 3**

*How does using web-based polling influence instructor’s success when revising the course content?* An analysis revealed that among the students who were in the web-based polling group, the majority (71.7%) responded to the in-class polls via text messaging, whereas most students (95.5%) responded to the pre-class polls via a web browser. On average, 55.57% of the students answered pre-class polling questions correctly, whereas 79.87% provided correct responses when the instructors re-polling the same or similar questions during the lecture, which suggests that there was a 24.3% improvement after the instructor gauged students’ understanding prior to each lecture and modified the lecture for the purpose of PoTT. On average, the instructors modified 15.8% of the lecture and learning activities prior to the day of class based on the students’ answers to the pre-class questions that were posted on PollEverywhere.com each week.

A summary of the means, standard deviations, and Pearson correlation coefficients for the measured variables are listed in Table 3. Contrary to expectations, the percentage of correct answers for the pre-class questions was not significantly correlated with the percentage of the lectures modified by the instructors ($r = .080, p = .606$). Thus, the amount of lecture modification did not appear to match students’ pre-class polling results. However, results from the focus meetings showed that instructors applied the PoTT technique and helped students address the initial gaps in their learning by modifying the lectures each week, which indicates that our pilot quantitative measure for PoTT may need to be revised to improve its accuracy. Moreover, most instructors believed that posting the same or similar questions at the end of the class provided them with a greater awareness of the amount of knowledge that students retained after each class. Self-reports from the instructors also revealed that they had a positive perception of the web-based polling tools and experienced educational benefits when using the pre- and end-of-class polls, as was evident in the following two instructors’ comments:

- Web-based polling tools facilitated in-class discussion. Asking students questions via PollEverywhere.com before the lecture allowed them to think about the subjects before class and be more curious and eager to figure things out. Most students read the materials ahead so they were more prepared. (Instructor A)
- Students liked the pre-class questions. When they came to the class, they were attentive to find the answers. Web-based polling tools helped develop students’ meta-cognitive awareness! (Instructor B)

**Table 3. Means, standard deviations, and Pearson product correlations for the measured variables**

<table>
<thead>
<tr>
<th>Variable</th>
<th>$M$</th>
<th>$SD$</th>
<th>$r$</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Student Answer Pre</td>
<td>0.56</td>
<td>.19</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Student Answer Post</td>
<td>0.80</td>
<td>.16</td>
<td>-.216</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Lecture Modified</td>
<td>0.16</td>
<td>.08</td>
<td>.080</td>
<td>-.366*</td>
<td></td>
</tr>
</tbody>
</table>

*Note. Student Answer Pre = Percentage of correct answers for the pre-class questions; Student Answer Post = Percentage of correct answers for the end-of-class questions; Lecture Modified = Percentage of the lecture modified by the instructors based on the students’ answers to the pre-class questions

*$p < .05$

**Discussion and implications**

The results of this study both confirm that the use of in-class polls results in higher levels of engagement (Bode et al., 2009; Dallaire, 2011; Lasry, 2008; Stowell & Nelson, 2007; Trees & Jackson, 2007) and suggest that web-based polling, with its use of pre- and post-class questions, and use of the PoTT strategy during class were associated with
higher levels of specific types of student engagement, including emotional and cognitive engagement, than the exclusive use of clickers during class. Given that emotional and cognitive engagement refer to students’ feelings and their voluntary efforts with regard to challenging tasks (Finn & Voelkl, 1993; Fredricks et al., 2004), these results suggest that the use of the PoTT strategy creates an environment that facilitates students’ positive emotions and helps students concentrate on the classroom instruction.

Contrary to expectations, the results showed that the students in the clicker group had significantly higher levels of self-efficacy for learning and performance, which is an important learning factor in academic settings (Bandura, 1977), than those in the web-based polling group. However, the fact that there were no differences in the levels of self-efficacy between the undergraduates who used clickers and those who used web-based polling implies that the higher levels of students’ self-efficacy in the clicker group may not necessarily have resulted from the use of the clickers. The difficulty level of graduate courses may be higher than that of undergraduate courses, resulting in lower levels of self-efficacy for learning and performance for the graduate participants in this study. One additional consideration is that the graduate students had more time to read, think about, and respond to web-based polling, whereas the undergraduate clicker group responded in real time to the questions that were posed in class. Pedagogically speaking, instructors may want to use in-class polling, such as with clickers, to review factually based information or for discussing attitudes and beliefs about a topic using a Likert-scale. In these cases, the cognitive processing demands are not as taxing given that students are recalling factual or conceptual knowledge or have most likely already formed opinions for Likert-scale polls. Conversely, questions that are more cognitively demanding, such as those that ask students to analyze or evaluate a concept (Anderson & Krathwohl, 2001), may be better disseminated through a web-based polling system to allow students more time to process the information.

According to the information gathered from the faculty focus group, the instructors reported favorable experiences with web-based polling tools with regard to gauging students’ understanding before the lecture, although, according to our pilot quantitative measure, the instructors did not appear to modify their lectures accordingly. This may be due to the novel use of web-based polling and PoTT, in that the instructors may not have felt equipped to modify content or instruction based on the students’ feedback. Instructors noticed that students tended to be better prepared for class as a result of the pre-class polls. This finding indicates the possible benefit of using web-based polling tools to increase students’ motivation and their knowledge retention of class materials, which was demonstrated by the results of the quantitative measure and the faculty focus group meeting. Given that previous research has shown little to no relationship between polling and academic performance (Anthis, 2011; Elicker & McConnell, 2011; Kennedy & Cutts, 2005; Stowell & Nelson, 2007), the findings of the current study suggest that instructors who wish to incorporate polling strategies should expect to see benefits with regard to students’ motivation and their learning factors, but not in their academic outcomes. One significant implication for instructors is that the use of the PoTT approach demands the willingness to modify and change instruction to meet the students’ needs. Although course syllabi are created prior to the instruction, students’ learning of the content may fall behind or pass the indicated pace of the syllabus. This means that instructors need to be more flexible in the ultimate scope and sequence of a course and understand that web-based polling in advance of a class may reflect a wide range of students’ understanding.

Finally, although instructors can use clickers to facilitate Just-in-Time Teaching (JiTT), gauging students’ understanding with in-class clicker polls, simultaneously modifying lectures may result in instructors’ cognitive overload (Sweller, 1988; van Merrienboer & Sweller, 2005), which may in turn affect their teaching performance (Feldon, 2007). Plenty-of-Time Teaching (PoTT) takes advantage of web-based polling tools by allowing instructors to gauge students’ understanding before the actual class, which in turn provides them with sufficient time to modify their lectures.

Conclusion

Given that educational technologies change rapidly over time, the results of this study signify the role of polling tools, provide innovative ways to implement JiTT or PoTT, such as gauging students’ understanding with pre-class polls, and offer insights that can benefit educators who wish to promote students’ emotional and cognitive engagement with various types of feedback devices. Future research should utilize in-depth qualitative data analyses to improve the validity of the findings and make it possible to understand the learning processes and benefits of polling strategies from the students’ perspective.
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