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The Influence of Tech-Savvyness and Clicker Use on Student Learning

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Keywords

Student response systems, Clickers, Student technology proficiency, Engagement, Academic performance

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Abstract

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Introduction

Student response systems, commonly called clickers, are a relatively new method for engaging students in the college classroom. These cell-phone sized devices have a keypad and use interactive technology that allows students to answer questions posted on PowerPoint slides. Immediate feedback can be given once all students have answered the question in the form of colorful bar graphs, providing a practical way to inform both the students and instructor whether the students comprehend course content. Although much of the recent literature on the use of clickers in classrooms has focused on the pedagogical purposes of this technology (i.e. Beekes, 2006; Cleary, 2008; Kaleta & Joosten, 2007; Morling, McAuliffe, Coh, & DiLorenzo, 2008; Trees & Jackson, 2007; Wit, 2003), little is known about whether their appeal is related to our society's acceptance of technology in general. In a culture where educational institutions continue to stress information literacy and technology use, it could be that clicker popularity among students and instructors is related to our cultural familiarity with technology, rather than solely because clickers help students learn. Previous studies have not separated technology familiarity from the appeal of clickers and their ability to enhance learning. Given academic achievement is supported by engagement (Finn, 1992; Finn and Voelkl, 1993), and perception and acceptance of technology is a prerequisite to students using technology (Lewis, Coursol, & Khan, 2001), the current study evaluates the influence of clicker use in the classroom and students'

technology proficiency (STP) on students' perceptions of clickers, student engagement, and course grade point average. The overall goal of this project is to facilitate a clearer examination of the role of technology in the classroom.

Evidence suggests that students perceive clickers as useful devices in the classroom. Draper and Brown (2004) surveyed students to find that using clickers in class allowed students to identify content areas they did not fully understand. Importantly, students also found useful that instructors could alter their lesson plan "on the fly" if they found through students' answers to a question that many students were having difficulty with a specific concept covered in class. This idea – coined "contingent teaching" by Draper and Brown (2004) – focuses on the role of the instructor as one who responds to the needs of the students rather than to the predetermined set of lecture notes. In fact, anecdotal evidence from an instructor interviewed by Boyle and Nicol (2003) suggests that "the questioning process...gives you more information about where the students are coming from and you learn what misunderstandings or misconceptions they have" (p. 52). This process allows the instructor to be attentive to student learning, and the student is engaged in the instructor's teaching; conceivably an ideal teaching/learning relationship. Thus, it is no surprise that some students report more enjoyment in clicker classes relative to standard lectures. Indeed, in one study (Marlow, Wash, Chapman, & Dale, 2009) clicker class attendance was consistently at 80 to 90%, partly because students enjoyed using clickers.

Various researchers have sought to discover the specifics behind students' enjoyment of clickers in the classroom. Boyle and Nicol (2003) found students in clicker classes felt they developed a better understanding of the subject matter relative to standard lectures. Students reported having to think more in clicker classes and were able to remember more of the information from a clicker class relative to standard lectures. These findings are likely driven by the fact that students had to attend the lectures to earn the points available through the use of the clicker. Likewise, should students not attend class and, thus, score poorly in courses in which clickers are utilized, clickers are likely to be viewed as less helpful in the learning process relative to those who are performing well in courses (Trees and Jackson, 2007). In other words, course performance may influence students' perceptions of the usefulness of a clicker in class. In the present study, we explore the possibility that academic performance (course grade) has less to do with clickers than previously considered.

In addition, students' perceptions of clickers are driven by the fact a standard lecture can be turned into an interactive pedagogical moment where students can collectively answer questions, and get instant feedback. The feedback is unique because clickers can instantly aggregate responses, which allows students to stay anonymous, yet contribute to discussions on the content discussed during class. Students' ability to answer truthfully without embarrassment can instill a sense of ownership over the answer they choose. The sense of ownership can be used as a catalyst to improve the quality of student thought (Marlow, et al., 2009). Certainly, before the introduction of the clicker into university classrooms, instructors still engaged their students through other methods, such as raising hands in response to a query. Yet some research has shown that additional engagement can come from the clicker class environment.

For example, Stowell and Nelson (2007) asked students to rate their emotions before, during, and after an introductory psychology lecture. During the lecture, students were exposed to one of four environments: (1) standard lecture with no review questions, (2) review questions requiring a response through raising hands, (3) review questions requiring students to hold up response cards, and (4) review questions requiring students to answer using their clicker. The most noted finding was the level of honesty reported by the

students. Those in the clicker group were more honest in their answers given they were not able to socially conform and answer in the way they saw others answer (versus the other methods that require commitment before all answers are collected). Thus, while it may appear that many students raise their hand and are engaged in a course requiring the raising of hands as a response to a query, often that engagement is with their peers as they look around the room. The use of clickers allowed the student to engage in the material of the class, leaving them to answer what they think is the correct answer and not what other students respond as the correct answer. This anonymity is likely appealing to a generation of students who are used to communicating while remaining unidentified. Just as a person can post comments using a pseudo-name to another's Twitter page, or in a chat room, a student can answer using clickers without anyone but that student knowing his response. The current generation of students, *digital natives* or members of *Generation NeXt* that were born between 1981 and the 1990s, who have always known cell phones, computers and the Internet (Pew Research Center, 2007), is more likely to interact in class if they can use a device to mediate classroom apprehension.

But what if a student wants to be engaged but is resistant to change, is apprehensive about technology affecting his or her grades, or is generally not comfortable with technology? Does he or she share in the enjoyment that using clickers in the classroom may bring? Lewis, et al. (2001) examined college students' tendencies and comfort level with different types of technology. Overall, students felt quite comfortable with e-mail and with general Internet use. Their social networking skills allow them to communicate with others in a non-threatening environment, one that does not require the student to have their questions or comments linked to their face, a prospect students can find intimidating in class. Alternately, research has shown that lack of comfort with technology can negatively impact students' progress (Zhang & Espinoza, 1998). Computer self-efficacy, or an "individual's confidence in his/her ability to use computers" (para. 3) directly influenced the choice to perform a given task. It could be, then, that for students to use clickers with ease they must have the confidence to do so. We speculate that a student's clicker-use behavior (especially for those not so comfortable with technology or resistant to change) is derived from the teacher's ability to engage students in the material. There are definite chances that technology detracts from learning, regardless of enjoyment.

In addition to investigating the role of clickers on student engagement, the impact of clicker technology on grades is an important question given that grades are a common measure of academic performance. Mayer, et al. (2009) exposed students to one of three situations: 1) a large lecture course in which the instructor did not utilize clickers but did ask at various points throughout each class if there were questions, (2) the same large lecture course in which the instructor did utilize clickers by asking two to four multiple-choice questions during the lecture, or (3) the same large lecture course in which the instructor utilized group multiple-choice questioning without the use of clickers. Their results demonstrated that students in the clicker section scored significantly higher on exams relative to the students who received no questions and those who received group questions. They suggest, then, that the *use of clickers* can improve students' academic performance. However, using a similar method, Campbell (2007) showed that students who had higher class standing (overall GPA), but were not in clicker classes, outperformed those who were in clicker classes, suggesting that the student's *overall academic achievement* played an important role in determining grades.

Given the apparent conflicting findings about technology in the classroom, the following research questions were examined:

RQ1: Does student perception of clickers, student engagement, and course GPA differ for students who are in clickers classes compared to students that are not in clickers classes?

RQ2: Does student perception of clickers, student engagement, and course GPA differ for students who are technologically proficient compared to students who are not technologically proficient?

Method

Participants

There were 405 respondents in the study. The participants were students recruited from a regional Midwestern university either through classes, or utilizing an online system that posts opportunities for students to participate in research. Thirty-three percent were freshman ($n=127$), 24% were sophomores ($n=93$), 23% were juniors ($n=87$), and 20% were seniors and beyond ($n=76$).

A subsample was selected to account for the use of Student Technology Proficiency (STP) as an independent variable. Since a requirement of multivariate analysis is that independent variables are categorical, the tech savvy data were trimmed to two values: low STP and high STP. The lowest 19% of scores ($n = 76$) on the STP scale signified the low proficiency sample, or those with low levels of tech savvyness. Similarly, the top 19% of scores ($n = 76$) were used from the total sample to indicate the high technology proficiency sample, or those with high levels of tech savvyness. This procedure reduced the sample to 152 participants. Garcia and Zapf (in press) created the valid and reliable measure of STP (chronbach's alpha = .82). The current sample had higher reliability (chronbach's alpha = .88). Seventy percent of participants ($n = 106$) were currently in a clicker class, and 30% ($n = 46$) were not. There were more females in the study ($n = 103$) compared to males ($n=48$), and 1 non-respondent. Seventy-six percent of participants were below 21 years of age, with a mean age of 21 years ($SD = 3.65$) with values ranging from 18 to 46 years. Twenty-eight percent were freshman ($n = 43$), 26% were sophomores ($n = 40$), 24% were juniors ($n = 37$), 20% were seniors and beyond ($n = 30$), and 2 did not respond. Multivariate analysis was completed with this smaller sample.

Materials

The first independent variable was STP (Garcia and Zapf, in press). The second independent variable, student enrollment in a clicker class, was collected using a single item in the questionnaire which asked whether the student was currently enrolled in a course that used clickers. To measure two key dependent variables – perception of clickers and student engagement – it was necessary to create new instruments. The instrument created to measure students' perceptions of clickers was developed by modifying 21 existing items which were taken from studies relevant to the current research project (Kaleta & Joosten, 2007; Draper & Brown, 2004; Boyle & Nicole, 2003; Jackson & Trees, 2003). For example, the items adapted from Boyle and Nicole's (2003) study referred to "personal response systems," but for consistency in the current study this phrase was reworded as "clickers." After completing exploratory factor analysis with varimax rotation, the original 21 items were reduced to 7 items. Fifty-eight percent of variability was explained with the items. Reliability for the seven items was .88. Table 1 displays the final seven items with corresponding factor loadings. These were the items used to measure perception of clickers.

Table 1. Item Breakdown for Dependent Variables and Component Loadings

Dependent Variable	Factor Loadings
Perception of Clickers	
1. Using clickers helps me develop a better understanding of the subject matter when compared to traditional lecture based classes.	.838
2. Clickers have been beneficial to my learning.	.808
3. Using clickers helped me to pay attention in class.	.780
4. Using clickers helps me to understand the concepts behind the problems.	.820
5. Clicker questions helped me to know how well I was learning the material.	.676
6. Using the clickers helped me get a better grade in this class.	.837
7. I pay attention to whether or not my answer to a clicker question was right or wrong.	.527
Student Engagement	
As a result of my involvement in this class, I	
1. Asked questions in class or contributed to class discussions.	.945
2. Discussed ideas from the readings for this class with other students in this course.	.914
3. Discussed grades or assignments with your Instructor for this course.	.955
4. Talked about career plans with your Instructor for this course.	.957
5. Discussed ideas from your readings in this class with your Instructor for this course.	.914
6. Had serious conversations with students of different perspectives or personal values than you.	.946

The student engagement instrument was created by selecting items relevant to the study from the reputable National Survey of Student Engagement (NSSE) engagement indicators (Kuh, 2001). The NSSE instrument asks students to think about their overall college experience, rather than individual classes. In our study, we inquired about individual classes. Thus, NSSE questions were used but modified to account for this difference in goals. Also, five NSSE indicators were previously validated, however for the current study we selected items broadly from the questionnaire for relevance to our research questions, and revalidated based on our understanding of engagement in an individual class. For example, some items referred to the particular university the student attended (e.g. "to what extent does your institution emphasize each of the following."). These questions were disregarded. We chose items that reflected engagement in the classroom, and not students' overall educational experience. We chose 20 items for the questionnaire. After completing an exploratory factor analysis with varimax rotation, the original 20 items were reduced to six items. Reliability for the six items was .97. Eighty-eight percent of the variance was explained by the six items. Table 1 displays the final six items with corresponding factor loadings. These were the items used to measure student engagement in the classroom.

Procedure and Design

The questionnaire measuring STP, perception of clickers, and student engagement was administered online to students. All closed-ended questions used a 4-point Likert scale; for example, on the engagement scale students could select strongly disagree, disagree, agree, or strongly agree. Since we were interested in the educational experience that students had in a particular class, we asked participants to only consider one class, and answer all questions based on their experiences in that one class. Students were free to think about a clicker or non-clicker class. The questionnaire began with items about their perception of clickers which were presented in a random order. Next, items about STP were presented, followed by engagement items which, again, were all randomly ordered. Finally, demographic information was collected, including enrollment in a clicker class or not, year in school, gender, and major. Completing the questionnaire took under 10 minutes. Course GPA was collected after the semester ended.

The experiment was a 2 x 2 quasi-experimental design with two independent variables (enrollment in clicker class, yes/no; student technology proficiency, high/low), and three dependent variables (perception of clickers; student engagement; course GPA).

Results

The research questions were analyzed using multivariate analysis of variance (MANOVA). The independent variables were enrollment in a clicker class and STP. The dependent variables were perception of clickers, student engagement, and course GPA. Bartlett's test of sphericity (35.40, $df = 18$, $p < .05$) indicated MANOVA was appropriate. Results of MANOVA are presented in order of research questions, starting with the effects of student enrollment in a clicker class.

RQ1 investigated the effect of student enrollment in clicker classes versus non-clicker classes. Table 2 displays the means and standard deviations for these research questions. The multivariate main effect of enrollment in clicker class was not significant, Wilks' lambda = .97, $F(3,73) = .83$, $p = ns$, power = .22. There were no significant findings at the univariate level: perception of clickers, $F(1,79) = 1.01$, $p = ns$, power = .17, student engagement, $F(1,79) = 1.52$, $p = ns$, power = .23, and course GPA, $F(1,79) = .21$, $p = ns$, power = .07. These findings indicated that a student's involvement in clicker classes versus students not enrolled in clicker classes did not appear to change their perception of clickers, level of engagement in classroom activities, or student final class grade-point-average.

Next, RQ2 was explored for differences between high STP and low STP students. Table 2 contains means and standard deviations for this research question. The multivariate main effect of STP was significant, Wilks' lambda = .83, $F(3,73) = 5.15$, $p < .05$. There were three significant univariate effects: perception of clickers, $F(1,79) = 7.08$, $p < .05$, $\eta^2 = .09$, student engagement, $F(1,79) = 4.66$, $p < .05$, $\eta^2 = .06$, and course GPA, $F(1,79) = 4.14$, $p < .05$, $\eta^2 = .05$. Planned comparison of difference scores revealed that students who were less technological savvy were more engaged than those that were technologically proficient ($p < .05$). Students who were less savvy also had lower favorable perceptions of clickers than students who were highly technologically proficient ($p < .05$). Finally, students who were less technologically savvy had higher average course GPAs than students who were more technologically proficient ($p < .05$). In general, whether or not a student was enrolled in a clicker class had no impact on students' perception of clickers, student engagement, or course GPA, whether a student was low in STP or high in STP had significant impacts on all three dependent variables.

Table 2. Means and Standard Deviations for Dependent Variables

Dependent Variables	<u>Clicker Class</u>		<u>Technological Proficiency*</u>	
	Yes M (SD)	No M (SD)	High M (SD)	Low M (SD)
Student Engagement	2.33 (.28)	2.26 (.26)	2.27 (.31)	2.36 (.23)
Perception of Clickers	3.22 (.51)	2.95 (.65)	3.22 (.54)	2.88 (.53)
Course GPA	2.98 (1.12)	2.94 (1.12)	2.67 (1.24)	3.31 (.83)

* All findings were significant at $p < .05$ between high/low Technological Proficiency on the three dependent variables.

Discussion

The purpose of the current study was to separate the influences of clickers from STP to improve our understanding of the effect of clickers in college classrooms and therefore to examine the belief that using technology in the classroom is beneficial, regardless of pedagogy or student abilities. The research questions asked whether clickers themselves would have an influence on students' perception of clickers, classroom engagement, and academic performance, or whether STP might instead (or in addition to) play an important role in students' perception of clickers, classroom engagement, and academic performance. Contrary to previous research, students in clicker classes did not show increased favor towards clickers (Patry, 2009), higher engagement levels (Trees & Jackson, 2007; Beekes, 2006), or higher course grades compared to students who were not in clicker classes (Kaleta & Joosten, 2007). Our research found that STP did influence the dependent variables, and our interpretation of the findings support what classically trained teachers likely already suspect: technology alone does not guarantee learning.

On the findings regarding perception of clickers, there was no difference reported between those students enrolled in a clicker class and those not enrolled in a clicker class; yet students who were higher in STP had more favorable perceptions of the clickers than students low in STP. This could be due to a mix of high and low STP students in the classroom; no noticeable difference appeared between those enrolled and not enrolled in clicker classes because of STP characteristics that were present in all classes from which the sample was taken.

A second finding revealed that students who were low in STP were significantly more engaged than those high in STP. It could be that the difference in students' comfort level with technology influenced their engagement, regardless of their clicker class involvement. Not surprisingly, the higher STP students thought more favorably about the clicker's educational value likely because they were already comfortable with technology and, thus, "wired" to think the devices would aid their learning.

The final dependent variable, course grade point average, again demonstrated no significant difference between students in clicker and non-clicker classes. Some researchers would argue that this could be because learning happens through classroom engagement (Finn, 1992; Finn and Voelkl, 1993), or that the educational value of technology only occurs when

students are comfortable and knowledgeable with technology (Lewis, 2001). The current findings support a different view of clickers. Students low in STP earned higher grades; moreover, although these low STP students had less favorable perception of clickers, they were also more engaged in the classroom. Certainly the current study supports previous research that engagement is related to students' grades, given low STP students were more engaged and earned higher grades. Yet, comfort with and knowledge of clickers (high STP students) did not seem to improve engagement in the classroom or course grade. Marlow et al. (2009) investigated clickers use in four distinct disciplines. Their major conclusions support our findings; students perceived clickers to be excellent drivers of participation, but had doubts about the clickers' potential to increase learning.

As an example of how all three of the explored dependent variables interact, consider the following scenario: students low on STP may make more of an effort to stay engaged in ways not related to the use of clickers or technology (and throughout the semester increased their computer self-efficacy). In this way, there may be a tight connection between engagement and grades, rather than high expectations of clickers and grades. Given it was the low STP students who were more engaged and the low STP students who earned higher grades, it is likely that a critical element is the teacher/student interaction; one that should not be ignored or pushed aside. "Contingent teaching" is a crucial facet of using technology in the classroom, and is related more to effective teaching practices, rather than the technology itself. For example, Lantz (2010) prescribes a specific method for helping instructors use clickers to teach specific concepts. Students are stimulated by effective teaching practices, not clickers directly, but the students who recognize this connection the most are probably those who already pursue higher academic achievement.

Thus, unlike Mayer, et al. (2009), the current study has shown that using clickers in the classroom was not enough to bolster performance in a course. Could students high in STP rely too heavily on the use of clickers in the classroom, especially given their high expectations for their usefulness? In this way, then, these students may not utilize additional study methods, whereas the student who is low in STP, and does not have high expectations for the role of clickers in their learning, continues traditional study methods and, therefore, may earn a higher grade. Regardless, the crucial point for instructors is that classroom technology is related to student performance in the classroom, but perhaps in unexpected inverse relationships (e.g. highly tech savvy students may indeed do poorly with all else held constant). We should not overlook the possibility that some students may stick with courses simply because they think clickers are exciting, yet not give too much thought to their impact on the final grade.

There are three directions for future research thus far unexplored. First, it is necessary to further scrutinize clickers with qualitative research. Our path is to triangulate the current findings by conducting focus groups comprised of students from each of the four controlled conditions in this study. For example, we speculate that high STP students may be motivated to take clicker courses that are rich in technology use, but we do not know if there are other motivations, or whether other factors are influencing our dependent variables. Focus groups are specifically useful because they afford participants opportunities to explore and come to conclusions collectively; and thus we can attain a richer data set. Porter and Tousman's (2010) research on nursing students' perceptions of clickers is an example of statistical and qualitative inquiry. Second, new studies should investigate the *combined* effects of the teacher's methods with student technology proficiency. Nicolle and Lou's (2008) considered the factors that influence faculty to adopt technology. Evidence suggests that collegiality affects adoption of technology. We wonder whether factors that influence faculty to use technology and students' own comfort level can influence student learning. Third, additional research should investigate appropriate

methods for using clickers. In this study we suggest that using clickers helps teachers accomplish “contingent teaching” (Draper & Brown, 2004), an approach implemented by Porter and Tousman (2010) with “question-driven instruction,” but we do not test for methods of instruction with clickers.

The current research was originally motivated by the curiosity to determine whether clickers were useful in classrooms for educational purposes. We found that while clickers may be useful, they should be used with some degree of caution. As instructors, we must balance our desire to teach with technology because we think it could improve the learning experience, with the knowledge that technology is not a panacea for students doing well. Simply because students are savvy with technology, and because they have a positive perception about clickers, does not equate to higher grades. For those instructors that do use clickers, it is wise to dedicate time in class to discuss *why* clickers are beneficial, and then students can decide if they want to come along for the ride. The literature points to many valid scenarios where clickers can play a supporting role to an instructor’s pedagogical practices, such as classroom enjoyment (which may lead to engagement; Kaleta and Joosten, 2007). At the end of the day, however, relative to today’s modern cell phones and the many sophisticated networking devices that have infiltrated our culture, clickers are still very simple devices that, too, have their limits.

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