# EFFECTS OF CLASSROOM CELL PHONE USE ON EXPECTED AND ACTUAL LEARNING

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Studies of driving indicate that the conversational aspects of using cell phones generate high risks from divided attention. Prior surveys document high rates at which students carry phones to and use them during class. Some experiments have demonstrated that cell phones distract students from learning. The present studies combined survey and experimental methods to determine student expectations about and actual performance under cell phone use conditions. On the survey, students estimated the number of questions they could answer out of 10 when texting and when not texting. For the experiment, we used a repeated measures design with simulated classroom presentations and measured performance on a 10-item quiz. Students expected to lose close to 30% on a quiz and actually did lose close to 30% when texting. We discuss implications of our methodology and our findings for improving student learning.

Studies of drivers using cell phones reveal that the cognitive distraction of conversations significantly increases accident risk. The National Safety Council (2010) published a literature review explaining why cognitive load from cell phones produces inattention blindness for drivers. Strayer and Johnston (2001) showed that listening to music or even to a recorded book did not produce high accident risks, as did conversing on cell phones.

These findings are important for considering the potential effects of classroom texting on students' ability to learn presented material. Texting is conversational, though it involves visual instead of auditory "listening" as students read incoming messages, and manual instead of verbal "talking" as they reply. If conversational cognitive load increases accident risk for drivers, the same cognitive load should increase errors on tests of lesson material presented while students are texting.

*Survey Research*

Researchers have explored the distracting effects of cell phones in classrooms using surveys. Many students admit to using cell phones for social networking purposes in the classroom (Bayer, Klein, & Rubinstein, 2009; Besser, 2007; Kennedy & Smith, 2010; Rubinkam, 2010). Some studies documented perceptions of distraction from phone ringing

(Campbell, 2006) and from texting or sending instant messages during a class or study session (Besser, 2007; Kennedy & Smith, 2010; Levine, Waite, & Bowman, 2007). These studies employed survey responses to evaluate effects.

The typical measurement scales for such reports are quantitatively weak. For example, Besser (2007) and Kennedy and Smith (2010) measured student perceptions of the effects of cell phone use on class performance using statements with which respondents either agreed or disagreed. Besser's statement was about texting drawing attention away from class, and Kennedy and Smith's statement was about these activities helping class performance. These nominal measurements do not provide information about the quantity of expected information loss. Other researchers (Campbell, 2006; Levin, Waite, & Bowman, 2007) have expanded the number of response options. For example, Campbell (2006) used a 5-point Likert scale ranging from *strongly agree* to *strongly disagree* to evaluate student attitudes about the disruptive effects of ringing phones. Although these scales increase response variability, there is no clear relationship between level of agreement with a statement such as "when a mobile phone rings during class, it is a serious distraction" and any quantity of information loss.

The absence of clarity about the expected size of the effect presents additional interpretive problems. Some researchers have found a difference between expressed attitudes about phone risks and actual behavior. An American Automobile Association Foundation for Traffic Safety (2008) survey showed that drivers viewed cell phone use as a serious safety risk. Nevertheless, 46% of those claiming that such use was an "extremely serious risk" still reported using their phones while driving within 30 days prior to the interview. Kennedy and Smith (2010) reported similar discrepancies in student behavior. Although students generally "agreed" that cell phones disrupted classroom learning, they persisted in using their cell phones in the classroom. Levels of agreement do not clearly indicate the size of the expected effect. If respondents agree that risk is increased, but perceive that the risk is low, they may feel justified in ignoring the risk.

*Experimental Research*

Some researchers have employed experimental techniques to assess actual effects of cell phone activity on classroom-related performance. Bowman, Levine, Waite, and Gendron (2009) and Fox, Rosen, and Crawford (2009) compared comprehension scores for students who were or were not sending instant messages during a non-class reading task. Neither study revealed differences in comprehension, but completing the reading took significantly longer for those engaged in instant messaging. These results do not generalize to a lecture or discussion-based classroom environment where students do not control the timing of information.

Other researchers have experimentally explored distraction from a cell phone ringing in a classroom. In two studies, researchers compared classroom scores for material when no phone was ringing to scores when a phone was ringing (End, Worthman, Mathews, & Wetterau, 2010; Shelton, Elliott, Eaves, & Exner, 2009). In both studies, performance deteriorated significantly for material presented during the ringing condition. Performance decrements ranged from 25-40% during ringing periods. These two studies addressed distraction effects for bystanders and left open the question of distraction for texting performers.

Ellis, Daniels, and Jauregui (2010) most directly assessed the effects of texting on performers in a real classroom context. Students in the experimental condition sent three text messages to the instructor during the lecture. The control group presumably had turned their phones off. Experimental students scored significantly lower than control students did on a pop quiz at the end of class. Although this experiment comes directly from a classroom setting, sending a text message to a teacher who does not respond is likely not as distracting as a conversational texting dialogue.

*Purpose*

The above studies begin to explore how texting changes classroom learning. However, their limitations suggested the following research strategies. First, we designed both a survey to assess how much information students thought they would lose if they were texting, and a corresponding experiment to explore the actual loss of information. Second, we generated a survey response scale that had stronger numerical properties than dichotomous or Likert-scale response options. Third, our survey response scale had numerical properties that matched those of our experimental outcome variable. This match allowed us to compare quantity estimates of expected quiz score changes with experimental performance scores. Finally, we designed an experiment that approximated both the classroom environment and students' texting experiences. Hearing a cell phone ringing in a class distracts learners from lesson content. However, if increased cognitive load explains learning deficits from texting distraction, the most invasive distraction should occur for students actively engaged in texting conversations during a class. Implementing these developments permitted us to compare expected and actual effects of non-class-related texting on classroom learning. We expected that students would be aware of learning decrements produced by texting, and that their actual performance would confirm that expectation.

**Study 1**

This study employed a self-report survey to assess students' cell phone activity in classes and their expectations of the effects of such activity on learning outcomes. Unlike previous studies using self-report measures, we created a measure of anticipated learning deficits from texting based on measurements common to classroom settings.

*Method*

**Participants**. We collected surveys from 693 students at seven colleges and universities across the United States during October through December, 2009. Seven teachers at these schools administered the surveys in their classes during class time. Participants' average age was 20.5 years. Ninety-nine percent owned cell phones. They had owned cell phones an

Table 1

*Verbal and Quantitative Comparison of Self-Described Texting*

| | | How Often Do You Text in a Day? | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0 - 25 times | 26 - 50 times | 51 - 75 times | 76 - 100 times | 100+ times | Total |
| How Would You Describe Yourself as a Text User? | Emergency-only | 5 | 0 | 0 | 0 | 0 | 5 |
| | Minimal | 53 | 7 | 1 | 1 | 1 | 63 |
| | Moderate | 84 | 87 | 46 | 23 | 14 | 254 |
| | Avid | 21 | 54 | 70 | 76 | 139 | 360 |
| Total | | 163 | 148 | 117 | 100 | 154 | 682 |

average of 5.4 years and used texting functions an average of 4.1 years.

**Instrument**. Our survey requested demographic information from students (summarized above), and information about frequency of carrying their phones and texting frequency in various daily activity contexts. Participants also estimated their expected learning performance if they texted during class. Our metric for performance was the question, "If you were listening to some information, and someone asked you 10 factual questions about that information, estimate the number of questions you might be able to correctly answer?" Participants answered that question for two conditions—if they were and were not texting while they listened to the information.

**Procedure**. Instructors read an introductory script to their classes that provided instructions and the informed consent option of not completing the survey. Surveys were confidential, and students completed them during a 6-minute time limit.

*Results*

More than half (52.8%) of our respondents described themselves as "avid users" and 90% described themselves as moderate or avid users. These verbal categories corresponded with reported number of texts sent per day, $r_S(682) = .612, p < .01$, as shown in Table 1.

Most students carry their phones to class. Seventy-five percent reported carrying phones to class "always," and another 16.4% said "most of the time." These carrying frequencies were lower than when students performed daily errands (87% reported "always"), but higher than when in leisure activity (72% reported "always"), at work (61% reported "always"), or attending church (46% reported "always").

Students predicted scoring significantly better if not texting ($M$ = 8.93, $SD$ = 1.68) than if texting ($M$ = 6.01, $SD$ = 2.25), $t(676) = 31.31, p < .01$, effect size ($t/\sqrt{N}$) = 1.20. Low-frequency users expected greater decrements from texting ($M$ = 4.16, $SD$ = 2.77) than did moderate ($M$ = 3.01, $SD$ = 2.24) or higher-frequency users ($M$ = 2.61, $SD$ = 2.41), $F(2, 672) = 12.14$, $p$

< .01, effect size ($\eta^2$) = .035. A Tukey post-hoc test indicated that the low-frequency users differed significantly from both higher-frequency users.

*Discussion*

These data confirm prior reports of the ubiquity of cell phones in the classroom (Bayer, Klein, & Rubinstein, 2009; Besser, 2007; Kennedy & Smith, 2010; Rubinkam, 2010). They add contextual information to classroom frequency data, indicating that the classroom presents fewer inhibitions to phone use than do church and work settings.

More importantly, these data present a strong metric for expected learning effects of phone use in the classroom. Researchers can directly compare expected point losses on a 10-item quiz to actual performance from a classroom experiment.

## Study 2

We designed a simulated classroom in which we manipulated student texting. Our goal was to establish actual effects of texting on quiz performance, and compare this performance with expectations derived from the survey in Study 1.

*Method*

**Participants.** We randomly selected 82 names from a complete college student list, and 40 of these students (21 men and 19 women) agreed to participate. We believe this procedure produced a much better sample of students than the typical General Psychology student sample receiving course credit for participation. Our sample derived from random selection, and participants received no incentives for participation beyond being involved in and receiving information about the results of the project.

**Materials.** Participants brought their personal cell phones to a classroom that contained a computer, a projector and screen, and sound connectivity. Students had access to pencils and blank paper so they could take notes. Another room across the hallway was available for break periods between sessions and for co-experimenters who texted participants during testing.

We prepared two lessons for participants. Each lesson provided author and content information about the books, "Young Men and Fire" by Norman Maclean (1992), and "Let the Great World Spin" by Colum McCann (2009). No participant indicated any prior knowledge of either book. Each presentation consisted of a prerecorded narrative and accompanying, self-timed, PowerPoint presentation that lasted about 6 minutes. The presentations simulated classroom teaching. For each presentation, we prepared a 10-item multiple-choice quiz. We pretested the quizzes with people who had not read the books and modified them so that pretest scores were close to chance levels.

**Procedure.** We tested all participants twice—once while texting and once while not texting. We counterbalanced all story and condition orders, and each story appeared an equal number of times in each order condition. We tested texting and non-texting participants simultaneously in small groups depending on when participants could attend. Texting and non-texting participants sat on different sides of the room to reduce distraction. Co-experimenters sat in the room across the hall.

We told all participants that they would watch an informational presentation; they could take notes if they desired; and they should try to retain the presented information for a quiz following a 5-minute break. During the break, participants had access to refreshments. They were told not to discuss the content of the presentation.

We identified the texting condition for each participant before each presentation. The texting participants set their phones on vibrate, and were free to respond immediately to any texts that arrived. The non-texting participants turned off the vibrate function, placed their phones out of sight and did not use their phones during the presentation. Following the first quiz, the groups switched conditions for the second presentation.

The co-experimenters confirmed phone functionality with participants before the experiment began. Following confirmation, the experimenter signaled co-experimenters to begin texting the participants. When all texting participants received their first message, the experimenter started the PowerPoint presentation. Co-experimenters exchanged messages as quickly as possible with assigned participants throughout the presentation. We prepared a list of texting topics involving general introductory information, but allowed texting content to develop spontaneously throughout the interactions.

*Results*

Quiz scores were significantly lower when students texted ($M = 6.02$, $SD = 2.224$) than when they did not text ($M = 8.25$, $SD = 1.597$), $t(39) = 5.34$, $p < .01$, effect size ($t/\sqrt{N}$) = .84. The difference in scores represented a 27% decline during texting from the non-texting performance. Neither the story during which they texted, nor the order of texting and non-texting, produced different results.

For a convenience sample of 15 students, we recorded the time participants actually spent reading or texting on their phone during the texting phase. Participants spent an average of 2.69 minutes engaged in texting during the presentation. The range of texting times was from 1.5 to 4.25 minutes. Time engaged in texting was negatively, though not significantly, correlated with quiz score in the texting phase, $r(13) = -.472$, $p = .076$.

*Discussion*

Our data support a prior report (Ellis, Daniels, & Jauregui, 2010) of deleterious effects of texting on classroom learning. Score reductions for texting conditions were greater in our experiment than in the prior experiment. Our methodological addition of conversational texting may account for our greater score reductions.

Although the correlation between texting time and texting score was not significant, the direction and size of the correlation leave open possibilities that level of engagement in texting is a factor in losing classroom information.

Our method presents a strong tool for evaluating the effects of texting on learning. The counterbalanced, repeated-measures design controlled subject and order variables. The pre-recorded presentations equated lesson materials for all participants across testing sessions. Nevertheless, due to phone connectivity differences, participants spent widely differing amounts of time actually engaged in texting. We expect that methodological refinements could demonstrate even greater loss of information than we found.

**General Discussion**

Our research successfully implemented a survey measure of students' expectations about the effects of texting on learning that was comparable to typical classroom measures—predicted quiz scores. The measure is quantitatively strong—a ratio measurement scale—and easy for respondents to understand. The data confirmed that self-report measures can provide information that is verified in experimental outcome studies. One remaining limitation is that students may fail to account for chance performance levels associated with multiple-choice questions. With four response alternatives, that chance level—25%—represents no significant learning. It is likely that those students who predicted scores lower than chance did not understand this baseline minimum.

The texting manipulation in the simulated classroom environment more closely approximated texting during real class sessions than previous experiments. Students in the texting condition responded to messages from their own friends as well as from co-experimenters. The messages engaged participants in conversation, a procedure that the driving studies (National Safety Council, 2010; Strayer & Johnston, 2001) suggested as a source of distraction and one that was missing from the Ellis, Daniels, and Jaurgui (2010) study. This engagement likely accounted for more information loss in our study than Ellis, Daniels, and Jaurgui (2010) found. Furthermore, the conversations occurred simultaneously with the lesson presentation, unlike the studies reported by Bowman, Levine, Waite, and Gendron (2009) and Fox, Rosen, and Crawford (2009). The differences in information loss that we obtained, in contrast to Bowman, Levine, Waite, and Gendron (2009) and Fox, Rosen, and Crawford (2009) support the idea that cognitive load increases when information presentation conflicts with texting communications. One remaining difference between our experimental setting and a real classroom is that some students commented about how different it was to freely text during a classroom presentation.

Our data confirm that students expect texting to disrupt their classroom learning, and that texting does disrupt learning. The real score declines (27%) approximated the expected declines (33%). The somewhat higher expected declines could have occurred as students failed to account for the 25% chance baseline and from texting requirements that did not occupy all of the lesson time. The corresponding declines for self-report and experimental measurements suggest that students are aware that using cell phones for personal communication in class compromises classroom learning. Thus, our data support the value of self-reports of the effects of using cell phones on learning, at least as presented with the measurement tools we used.

Survey participants varied considerably in their score predictions under texting conditions. Some participants expected no detrimental effects of texting. Similarly, experimental participants varied considerably in their quiz scores under texting conditions. Some texting participants answered all questions correctly. We do not know if each participant's expected and actual performance measures were correlated because different participants completed the survey and the experiment. These data could reflect the same kind of discrepancies reported by the American Automobile Association Foundation for Traffic Safety (2008) between participants' expectations of safety risks for others but false immunity from risk for self. Further research could solicit information loss expectations from experimental participants to determine whether students can accurately predict their own distractibility.

Stanovich (2009) summarized two aspects of rationality—epistemic and instrumental. Epistemic rationality exists when a person's view of the way the world works matches the way it actually works. The correspondence of average expected and actual losses in our studies suggests a degree of epistemic rationality. Participants really do know what happens when students text. Instrumental rationality is evident when a person sets a goal and follows appropriate steps to achieve that goal. Our data suggest deficits in instrumental rationality for students who pay to become educated, yet choose to engage in counterproductive behaviors.

Given that students generally expect texting to disrupt their learning, researchers can reasonably ask why students risk potential failure to maintain social contact? Wei and Wang (2010) recently explored two models of student motivation for classroom texting. They predicted that instructor immediacy—making eye contact, calling students by name, talking with students outside of class, among other behaviors—could enhance students' motivation to learn and thus reduce texting. Alternatively, students' habits and gratifications they receive from the activity could maintain texting. Their data confirmed that immediacy enhanced motivation to learn, but that motivation did not correlate with texting rates. They concluded that the habits and gratifications model better fits their data. These results raise questions about how phone carrying habits and phone checking impulses relate to instructional variables. Students may benefit from knowing whether carrying their phones to class increases their impulses to check for messages. Likewise, teachers may want to know if interruptions to lesson flow increase students' urges to check their phones. These possibilities present fertile ground for future research.

Finally, faculty variations in handling texting events in classrooms may affect student behaviors in ways that alter learning. Further research could explore differences between faculty and students in perceptions of the effects of texting as well as of techniques for handling unwanted texting in class. Knowing such perceptions and the effectiveness of intervention techniques in the context of the demonstrated effects of texting could improve classroom environments and enhance student learning.

**Author Note**

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