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# Evaluating technology breaks on cell phone use in a college classroom

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Cell phones in the college classroom can be used to increase interaction between students and the professor; they can also distract from academic tasks and decrease academic performance. To decrease task-switching in the classroom, researchers have suggested the use of "technology breaks" (TB), in which students are provided periodic breaks to use cell phones throughout class. The purpose of the present study was to evaluate the use of technology breaks in a college classroom ($N = 21$). Cell phone use was evaluated over 22 class periods. Observers recorded how many students were using cell phones every 10 s. Three experiment conditions were alternated with yoked controls in a multi-element design: (A) 1 min technology breaks, (B) 2 min technology break, and (C) 4 min technology break. The control condition [question breaks, (QB)] provided breaks for students to ask the professor questions regarding class materials. No penalties or punishers were delivered for cell phone use under any conditions. The average rate of cellphone use in QB was 0.53 responses per min (range = 0.06–1.02), while the average rate for TB was 0.35 responses per min (range = 0.20–0.74). Overall, the study found that technology breaks were a promising way to utilize reinforcement-based strategies to reduce classroom cell phone use, though variability in the data weakened conclusions regarding the utility of technology breaks.

KEYWORDS

**technology break, pedagogy, cell phone policy, non-contingent reinforcement, motivating operation**

## Evaluation of technology breaks in a college classroom

Educators are faced with a dilemma regarding use of technology in their classrooms. Technologies can enhance learning by requiring interaction and active responses from students (Samson, 2010). Students can use cell phones, tablets, computers, and clickers to respond to classroom activities such as content questions. In this way, participating and learning can be enhanced for the entire classroom, especially compared to standard lecture. Large courses, in particular, are more likely to benefit from active response technology, because there are fewer opportunities for responding. By using active-responding technologies the teacher can readily assess comprehension of all students in the classroom. Researchers have demonstrated that the use of active response technologies resulted in a 4.7% increase in class grades in an undergraduate college classroom (Bojinova and Oigara, 2013). Cell phones have also been used to send reminders to high school students regarding class-relevant deadlines or activities (Thomas et al., 2011).

Markett et al. (2006) demonstrated that when using text messages in the classroom, a greater proportion of college students ask questions of the instructor than in standard lecture arrangements. Another gainful use of electronics is the use of phones to contact authorities in emergency situations. College students reported that they feel cell phones are critical for their safety in emergency situations on campus (Baker et al., 2012).

Alternatively, students may use electronic devices to engage in non-academic responses during class time, thus diminishing participation and classroom performance. Using phones or computers, students can engage in any number of non-classroom related activities, including text messaging, watching sports, reading the news, shopping, accessing social media, or checking email. Approximately 95% of college students bring their phones to class every day, and 29% bring laptops (Aguilar-Roca et al., 2012; Tindell and Bohlander, 2012). Of those students who bring their phones to class, 92% reported sending text messages during class at least once during the semester, and 30% reported sending text messages every class period (Tindell and Bohlander, 2012). Students self-report using their phones in classes 10.9 times per day for non-academic purposes (McCoy, 2013). Of students that used their phones in class, 80% indicated that this behavior was a distraction and caused them to miss instruction. Phones can also be used for nefarious purposes, such as cheating on exams. For example, Tindell and Bohlander (2012) found that 3% of their sample of college students admitted to using text messaging to cheat on an exam.

Using a cell phone in class should be considered task switching (away from academic responding), in the same way a pigeon can switch between operanda in an operant chamber. A sizable body of research, using a range of methods and outcome measures, has demonstrated that task-switching has adverse effects on learning and retention (Monsell, 2003). Three cell-phone polices that varied from none-to-extremely restrictive were implemented in a group-design among three sections of an undergraduate college class (McDonald, 2013). Regression models were used to predict scores on the final exam and found that 22% of the variance was accounted for by in-class texting, after adjusting for other academic performance measures such as grade point average and standardized test scores. Highly-controlled studies in analog settings have also demonstrated the effect of task-switching on learning. In a large group-design experiment 145 students were experimentally assigned to engage in various levels of electronic media and phone use (Kuznekoff et al., 2015). Depending on group assignment, participants engaged in low or high levels of Twitter communication or text messaging during a video lecture. Participants watched a video lecture, took notes, and then took an exam on the lecture material. The control group, that did not utilize electronics during the video lecture, had a 10%−17% higher grade on the exam. In a similarly designed study Rosen et al. (2011) found a 10.6% decrease in scores in high-texting groups. Wood et al. (2012) examined the effect of technology use in a college classroom on multiple-choice quiz scores. Students were either assigned to technology-use groups which were asked to utilize various technologies to communicate with others, or control groups which took notes in various forms. Students that did not use technology during class achieved higher quiz scores than students in technology-use groups.

There are two recent experimental evaluations of classroom policies to reduce cell phone or electronics use. In one such example, high school students were provided access to their cell phones for 10 min if all students in the classroom did not use their phones for the whole period (Jones et al., 2019). An ABAB design was utilized to evaluate the effect of this interdependent group-contingency. During the initial baseline phase, 88.0% of the class used cell phones, which was reduced to 16.5% during the initial intervention phase. In the final intervention phase, the class earned bonus cell phone time in six of seven class periods, demonstrating that this intervention was effective at reducing cell phone use to near zero. In another example, a punishment-based intervention was evaluated in a college classroom (Redner et al., 2020). A reprimand and point-loss contingency was evaluated in a multi-element design over the course of a college semester. A student who used an electronic device received a reprimand from the teacher and lost all participation points for that class period. Results indicated that electronics use occurred less often when the punishment contingency was in place (0.2% vs. 8.0% of students using electronics per interval). Importantly, average student quiz scores differed significantly between punishment and baseline conditions (83.0% vs. 77.0%, respectively). Nonetheless, the science of electronics policies is relatively young and additional efficacious interventions are needed.

One potential classroom intervention designed to increase attending to lecture content is the "technology break" (Rosen et al., 2013). Students are provided with periodic breaks to check in with their technology to reduce "internal and external distractions." When these authors refer to internal distractions, they are referring to internal dialogue or anxiety caused by not using phones for some duration of time. In an experimental evaluation of technology breaks, two college students were observed during analog study sessions (Guinness et al., 2018). The frequency of 1 min technology breaks was calculated based upon baseline use of electronic media. Both participants demonstrated substantial decreases in multimedia use during study time. This promising intervention needs to be tested for generality in other settings, including classroom settings.

The purpose of the present study was to experimentally evaluate the technology break (TB) intervention in a college classroom and measure its effect on cell phone use. Question breaks (control condition) and TB were alternated using a multi-element design in an undergraduate critical thinking class. This intervention uses fixed-time (FT) delivery of a reinforcer that may function as an abolishing operation (AO), the effects of which are (a) a reduction in the effectiveness of a cell phone as a reinforcer, and (b) a reduction in behaviors that result in access to the cell phone (Laraway et al., 2003). A review of time-based reinforcement [often called non-contingent reinforcement (NCR); see Poling and Normand, 1999 for a discussion on terms] described numerous benefits to the procedure: (a) it uses the functional reinforcer of the problem behavior, (b) it produces reductions is problem behavior comparable to a differential reinforcement of other behavior (DRO), (c) it uses a high rate of reinforcement, even compared to other differential reinforcement procedures, (d) fixed time reinforcement schedules are generally easy to implement, and (e) it doesn't produce high levels of extinction-induced problem behavior (Carr et al., 2000). Speaking colloquially, we might say the motivation to use cell phones during lecture may be reduced because access to cell phones was provided. Furthermore, most classroom electronics policies have restrictive and punitive components, whereas the technology break is reinforcement-based and does not include punitive or restrictive components. Therefore, such a policy would be preferred, given that data support its effectiveness.

# Method

## Participants and setting

Participants were undergraduate students from a large Midwestern university. Participants were included in this experiment by virtue of their enrollment in a lower division skeptical thinking course. The mean attendance over 22 class periods was 21 participants (range = 17–27). This study was reviewed and considered exempt by the University's Institutional Review Board because it evaluated a typical classroom procedure (therefore, informed consent was not required).

### Course overview

The content of the course was skeptical thinking, which included research on a variety of topics such as superstitious behavior and ineffective medical interventions (placebos). The classroom was a small room equipped with desks, a computer dock, and a projector. The duration of class was 1 h and 15 min, 2 days per week. Data were collected on cell phone use during lectures, group activities, and cell phone breaks. Other electronic devices (e.g., laptop computers, smart watches, tablets) were allowed, but data were not collected on their use. Lecture was delivered during the first part of class and the students interacted in groups during the second part of class.

## Dependent measures and data collection

Observers attended all class periods and recorded students' electronics use. Data were collected using the Planned Activity Check (PLACHECK) method. Every 10 s observers counted the number of students using cell phones in one row of seats. Then the following 10 s observers recorded data in the next row of seats. The following pattern continued until data were collected for the entire class per minute (i.e., six rows of students). Data were reported per minute intervals for all students (i.e., number of students interacting with cell phones per minute). Data were collected during lecture, and cell phone break. Cell phone use was operationally defined as any physical interaction with a cell phone (i.e., touching the cell phone). If students were oriented toward their phone without touching it this would not be counted as cell phone use. No distinction was made according to academic or non-academic electronics use. Data collected in this manner (similar to momentary time sampling) sample behavior and do not consistently over- or under- estimate responding (LeBlanc et al., 2016). Observers also counted the overall number of students in attendance and for each row. Data were not collected during the first minute of class (to allow students to hear the policy instructions and to put phones down). Cell phone use was also not collected for 30 s following the technology break to allow students to put cell phones away (otherwise putting phones away would be counted as use).

Each quiz had eight questions related to the weekly course lecture topic. Questions were randomly selected from a question bank. After the lecture, students received a paper copy of the quiz and a scantron. Scantrons were automatically scored using the University library services. Each quiz constituted 25 points of 1,000 points total of the course (2.5% of the grade).

## Experimental design and electronic policies

A multi-element design was implemented to evaluate technology and question breaks duration (1, 2, and 4 min). During question breaks, a no-cellphone use policy was established. During technology breaks, a cellphone-use policy was implemented. In either case, the professor would announce and explain the policy in effect at the beginning of the class period, and illustrated signs were posted that indicated the active policy. Two identical graphical 8.5″ × 11″ signs were placed prominently at the front of the classroom, one by each entrance. Question break and technology break policy signs were differentiated to increase the likelihood that students would distinguish between conditions.

### Question breaks

Signs with a red circle around a question mark and red lettering indicated that question breaks were in effect. At the beginning of class, the professor would state:

> "Today we will not be taking a technology break. We will have a question break instead. At one point during lecture, I will stop lecturing and allow you [1/2/4] minutes to ask questions. During question breaks I will be available to answer any content questions you may have. Just to remind you: There are no penalties for using your phone during class."

The question breaks (QB) occurred 15 min into a 30-min lecture. At the beginning of the QB, the professor would state "We are now starting a [1/2/4] minute question break. I encourage you to ask your questions now. Do not use your cell phone during the question break." The duration of breaks varied between 1, 2, and 4 min.

### Technology breaks

Signs with a red circle around a cellphone and red lettering indicated that technology breaks were in effect. A technology break occurred 15 min into a 45-min lecture. Studies have shown that increasing the reinforcement rate compared to baseline can reduce target behaviors (Wilder et al., 2000). Other studies have shown that higher density schedules of reinforcement delivery have resulted in larger reductions in problem behavior (Carr et al., 1998). Note that we refer to breaks as "Technology Breaks" rather than "Cell Phone Breaks" because it is a technical term used in previous literature (e.g., Rosen et al., 2013). At the beginning of class, the professor would state:

> "Today we will be taking technology breaks during class. At one point during lecture, I will stop lecturing and allow you [1/2/4] minutes to use your phone. These breaks are designed so that you have an opportunity to attend during lecture. There are no penalties for using your phone during class, though the breaks are designed to give you that opportunity. If you prefer not to use your phone, I will be available to answer any content questions you may have."

At the beginning of the technology break, the professor would state "We are now starting a [1/2/4] minute technology break. I encourage you to use your phones now. Checking them now may decrease your motivation to use them during instructional time." If students used their phones during lecture in this condition, there were no programmed consequences. The duration of breaks varied between 1, 2, and 4 min.

### End-of-break warning

A preliminary analysis of the data collected during the first 10 class periods showed an increase in cellphone uses over the first 2 min after the technology break. To test if a prompt could reduce this effect, an end-of-break warning was introduced immediately after the technology break. A power point slide with a "Technology break over" red sign and the message "Please remember to put your phones away or in silence" was displayed for 15 s. This warning was implemented starting on the 17th class period until the end of the study.

## Interobserver agreement

Interobserver agreement (IOA) was collected in six of 22 class periods (27%). Two observers scanned a seating row simultaneously from one side to the other in a predetermined direction (left-to-right). At the end of each interval both observers recorded the number of students they counted who were physically interacting with cell phones. This number was divided by the number of students in attendance and multiplied by 100 to get a percentage. IOA was calculated on an interval-by-interval basis (Doke and Risley, 1972; Symons et al., 2001). At each interval, the smaller percentage of students who were using electronics was divided by the larger percentage. When observers agreed on the percentage of students using electronics (including 0%) 100% was scored for that interval. The average IOA was 94.43% (range: 88.99%−99.54%). Note that IOA was high because most intervals did not have cell phone use and were scored as an agreement. Though not typically reported for this type of IOA, the average occurrence IOA was 94.43% (range: 88.99%−99.54%).

## Treatment integrity

Treatment integrity included a checklist that assessed the implementation of the cell phone use policy in place. Treatment integrity was collected during six of 22 class periods (27%). Treatment integrity was assessed once during each duration (1, 2, 4 min) of technology and question break conditions. For example, the checklist assessed whether (a) the instructor explained the cell phone policy in place at the beginning of class, (b) the correct materials clearly displayed the policy in effect, and (c) breaks occurred at the correct times and for appropriate durations. In all conditions, treatment integrity was 100%.

# Results

## Attendance

Attendance for 22 class periods averaged 21 students (range = 17–27). Average attendance for the 11 class periods in which a TB policy was in effect was 21 (range = 17–25), regardless of duration of the break. Average attendance in which a TB policy was in effect for 1-min breaks was 20 (range = 18–22) for four class periods, for 2-min breaks was 20 (range = 17–20) for three class periods, and for 4-min breaks was 22 (range = 19–25) for four class periods. Average attendance for the 11 class periods in which a Question break (QB) policy was in effect was 21 (range = 18–27). Average attendance in which a QB policy was in effect for 1-min breaks was 21 (range = 18–22) for four class periods, for 2-min breaks was 22 (range = 21–24) for three class periods, and for 4-min breaks was 21 (range = 18–27) for four class periods.

## Cellphone use and grades

The rate of cellphone use is reported in Figure 1. This rate was calculated by dividing the total frequency of cellphone use per number of 1-min intervals. The rate of cellphone use was calculated for QB and TB interventions across all duration conditions (1, 2, 4 min). Figure 1B shows QB and TB rate of cellphone use, regardless of duration condition. The average rate of cellphone use in QB was 0.53 (range = 0.06—.02), while the average rate for TB was 0.35 (range = 0.20–0.74). Except for the 6th class period, the rate of cellphone use for TB seems to have been maintained around 0.3 uses per minute. The rate of cellphone use in QB conditions increased at the beginning of the semester to 1/min and decreased consistently from the 7th class period onward, and it was maintained below 0.4 uses per minute, except for the 16th class period. The introduction of an end-of-break warning (starting on period 17th) did not affect cellphone use during TB conditions.

The average quiz percentage for QB was 64.31% (range = 43.11%−86.11%), while the quiz percentage for TB was 66.92% (range = 34.82%−88.17%). Because statistical tests indicated that the data were not normally distributed, a Wilcoxon signed-rank test was conducted between QB and TB quiz percentages, which indicated that quiz scores did not differ significantly ($Z = -0.56$, $p = 0.57$).

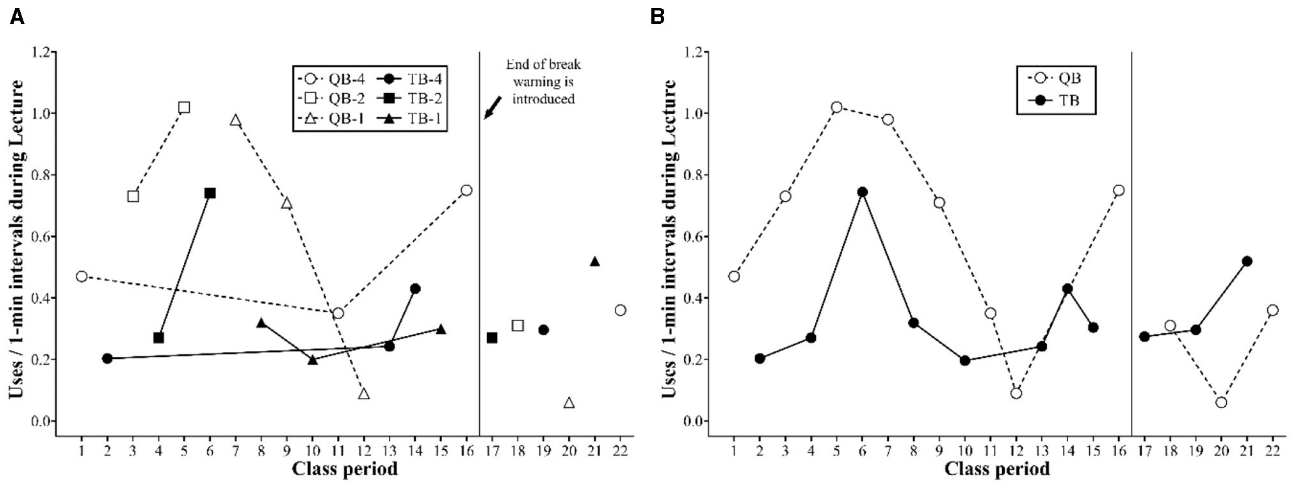


FIGURE 1
Cellphone use during each duration of Technology Break (TB) and Question Break (QB) conditions (1, 2, and 4 min). **(A)** shows rate of cellphone use for each duration of the QB and TB (1, 2, and 4 min). **(B)** shows rate of cellphone use across the 22 class periods for QB and TB, regardless of the duration of the breaks. Rate of cellphone use was calculated as the overall number of cellphone uses over the number of 1-min intervals. A vertical line between class period 16 and 17 indicates when the end-of-break warning was introduced (starting on period 17th).

Figure 1 shows that the rate of cellphone use in TB conditions was maintained around the 0.3 level across all durations (1, 2, and 4 min), except for the 6th class period (TB-2 min). The introduction of an end-of-break warning (starting on the 17th class) did not seem to affect cellphone use at any duration of TB. The rate of cellphone use during QB conditions varied widely, ranging between 0.1 and 1.0.

Higher average quiz percentages (over 80%) were consistently observed at TB 1-min, as compared to the other durations. To further explore differences in quiz performance between break durations, Wilcoxon signed-rank tests were conducted comparing the median quiz percentages across conditions (this test was chosen because data had nonnormal distributions). As shown in Figure 2, no significant differences were found in quiz scores across the different durations of QB. Conversely, significant differences were found between durations of TB. Namely, between TB 1-min ($Mdn = 77.46$, range = 28.57–100) and TB 2-min ($Mdn = 56.25$, range = 25–81.25; $Z = -3.82$, $p = 0.00$), TB 1-min and TB 4-min ($Mdn = 66.07$, range = 33.93–91.07; $Z = -2.92$, $p = 0.00$), TB 2-min and TB 4-min ($Z = -2.97$, $p = 0.00$). Comparisons between durations of TB and QB only showed significant differences between QB 1-min ($Mdn = 69.20$, range = 36.89–83.48) and TB 1-min ($Z = -2.37$, $p = 0.01$). Other differences were non-significant.

To further explore differences between break durations and possible effects within class periods, average cumulative cellphone use was calculated (by dividing the total cellphone uses per 10-s interval over the number of sessions for each condition). Figure 3A shows mean cumulative cellphone use during lecture time ***before*** and ***after*** QB and TB of 1-, 2- and 4-min. TB 1-min had the lowest cellphone use (1.25 uses) before the break, followed by TB 4-min (4.75 uses). Similarly, after the break, TB 1-min had the lowest cellphone use (8.50 uses), followed by TB 4-min (9.75 uses). There was a steep increase in cellphone use immediately following the 1-min (increment of three uses; second 1,000–1,100) and 4-min TB (increment of 1.75 uses; second 1,180–1,270).

## Cell phone use during breaks

Figure 3B shows the mean cumulative cellphone use during QB and TB durations of 1, 2, and 4 min. Cumulative cellphone use during the TB periods was similar across the different durations, at ∼15–20 uses per minute. Cumulative use during the QB periods remained close to zero, regardless of duration. Cell phone use rates during the 1-, 2-, and 4- min QBs was 0.25, 0.83, and 0.38 per min, respectively. Cell phone use rates during the in the 1-, 2-, and 4-min TBs was 18.25, 16.83, and 16.31 per min, respectively.

# Discussion

Rosen et al. (2013) recommended the use of technology breaks to reduce internal and external distractions that are caused by use and non-use of phones during class or study times. We experimentally evaluated the use of technology breaks in a non-analog college classroom over the course of a semester. To our knowledge, this is the first evaluation of technology breaks in a college classroom. Furthermore, there are very few studies that collected behavioral data on cell phone use in a classroom, and the study is noteworthy in that regard. When technology breaks were implemented, there was lower cell phone use compared to question breaks, but there was a high level of variability, so the results are difficult to interpret. One-minute technology breaks produced the lowest levels of cell phone use and produced a significant increase in quiz performance. Although we expected graded effects (i.e., longer duration breaks leading to less cell phone use) on behavior related to different durations of technology breaks we did not find this to be the case. If the data were graded according to the duration of the break, the lowest cell phone use would be in the 4-min technology break condition. Four-minute technology breaks also produced reductions in cell phone use compared to the 4-min question break condition, but not larger reductions compared

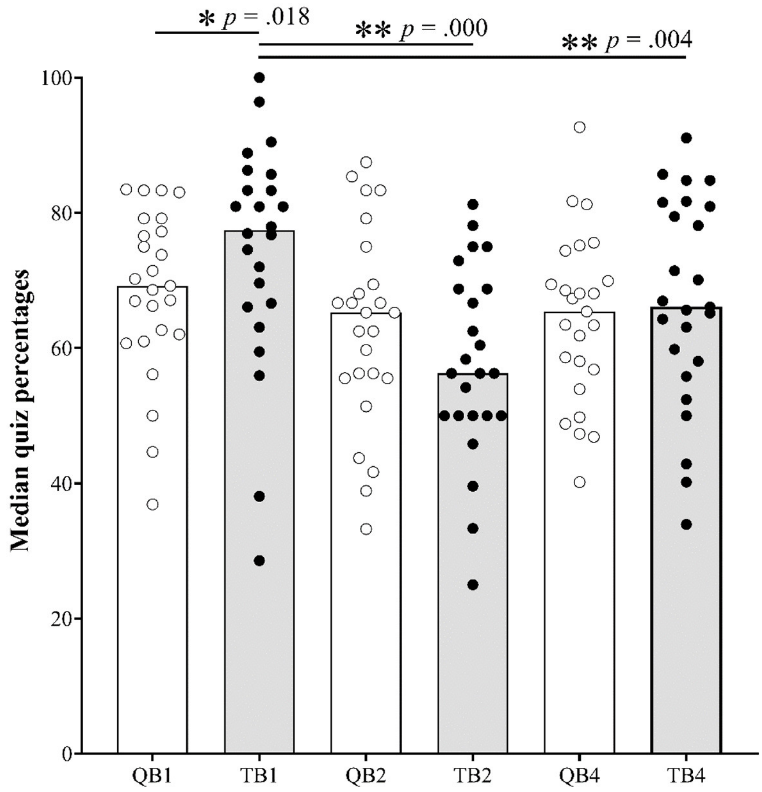


FIGURE 2
Median quiz percentages between conditions across break durations. Median quiz percentages for different durations of question break (QB) and technology break (TB) conditions (1, 2, and 4 min). White bars show median quiz percentages for all three QB durations. Gray bars show median quiz percentages for TB durations. White and filled circles represent average quiz scores for each student on the corresponding conditions of QB and TB, respectively. Horizontal lines represent statistically significant differences between conditions calculated using a Wilcoxon signed-rank test. $^{*}p < 0.05$, $^{**}p < 0.01$.

to 1-min technology breaks. In that sense 1-min breaks are the most efficient at producing behavior change and requires very little class time. It is interesting that these reductions in cell phone use were primarily produced prior to the technology breaks. We are cautiously optimistic about the effects of this intervention, though additional replication is needed. One benefit of the present intervention is that it is reinforcement-based and does not have adverse effects of punishment-based interventions. Our results provide further evidence to that of Guinness et al. (2018) who identified technology breaks were effective at reducing cell phone use during study times. Furthermore, the present study makes a contribution to the literature by providing observational data on cell phone use in the college classroom, whereas most previous studies rely on self-reporting.

The present study has a few important limitations that merit discussion. The main limitation of the present study is the variability which was observed in two of the datapoints in the main conditions and the unexpected reversal in the final condition. Cell phone use was high in one session of the 2-min technology break conditions (Session 6) and low in one session of the 1-min question break condition (Session 12). Reasons for this variability are unclear. Apart from those sessions the data in the main intervention condition were reasonably orderly. After we added prompts to technology break conditions, letting students know the break was coming to a close and that students should put their cell phones away, trends in the previous conditions reversed. This may have happened because grades become more valuable to students at the end of the semester (i.e., preference reversal). This could increase their attentiveness and relevant academic behaviors, resulting in a reduction in cell phone use. Second, we didn't collect data on laptop or smart-watch use. Students may have been using these alternative forms of technology to communicate with friends or send text messages. It is possible that some of variability in the data is due to students' use of other technology. Because the goal of the intervention was to find a strategy that didn't use punishment or restrictive practices we didn't ban other electronics. In that case, it would have been informative to at least have data on these devices, but, unfortunately, we didn't collect that data. Anecdotally, we estimate that 6–8 students per class period used their laptops during lecture. Even though numerous students used laptops during lecture it still appears most students used their cell phones during cell phone breaks (16–18 students per minute were on their phones during break). Future research should include other electronics use by incorporating them into the breaks, or by taking data on use of these other devices.

A few other features of the present study merit discussion. Even though there was some evidence cell phone use was reduced during intervention phases it was not reduced to near-zero levels.

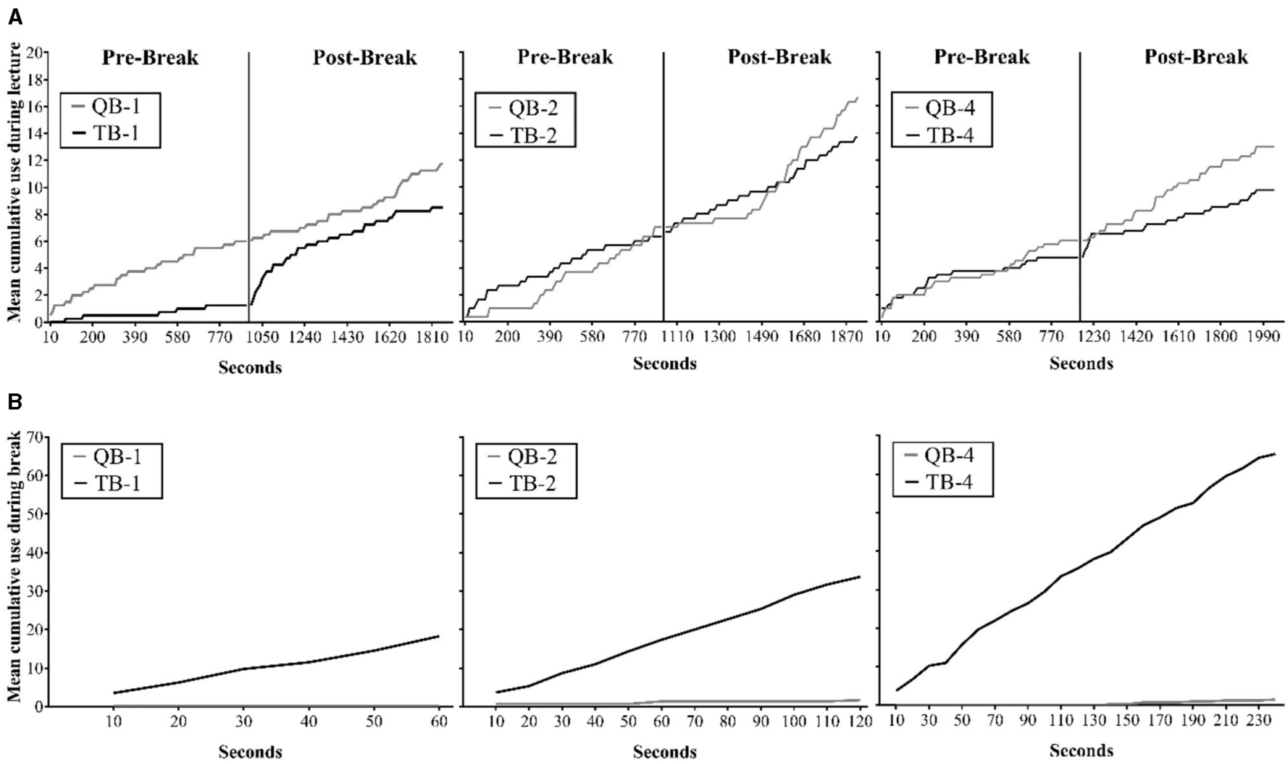


FIGURE 3
Mean cumulative cellphone use during lecture and break. Mean cumulative cellphone use during lecture time before and after QB and TB of 1, 2, and 4 min. Mean cumulative cellphone use was calculated using the mean cellphone use for every interval of 10-s over all sessions for each condition. Cumulative use during TB conditions is displayed with a black line, and during QB conditions with gray line. **(A)** Shows mean cumulative use during lecture time before and after the break for QB and TB conditions of 1 min **(left graph)**, 2 min **(middle graph)**, and 4 min **(right graph)**. **(B)** Shows mean cumulative use during QB and TB of 1 min **(left graph)**, 2 min **(middle)**, and 4 min **(right)**.

If the professor desires cell phone use to be non-existent, other interventions may be implicated, such as the interdependent group-contingency (Jones et al., 2019) or point-loss contingencies (Redner et al., 2020). In the interdependent-group contingency, the reinforcer was not provided unless there was zero cell phone use for the entire class (which was achieved by the class on numerous occasions). The technology break may not be the most effective among alternatives. Future comparative studies will help to determine best-practice electronics policies. Future research may also combine technology breaks with other interventions to increase its effectiveness.

Immediately following the 1- and 4- min technology breaks cell phone use increased rapidly for ∼1–2 min (Figure 3). In other words, students continued to use their cell phones once the technology break was over following both short- and long-technology breaks. This occurred even though students were provided 30 s to put their phones away (data on cell phone use were not collected for 30 s following the break). This sharp increase was not identified immediately after question break conditions. It would seem that students are either continuing on-going behavior that was occurring during the technology break or are responding to new phone-related stimuli following the technology break. Students may send text messages during the technology break and respond to text messages following the technology break. This treatment may have an iatrogenic component in the sense that cell phone use induces cell phone use in the near-term. One possible remedy to this issue would be to provide cell phone access at the end of the class period, similar to Jones et al. (2019).

The present data do not support the hypothesis that fixed-time delivery of cell phone access acts as an abolishing operation (AO), the effects of which are (a) a reduction in the effectiveness of a cell phone as a reinforcer, and (b) a reduction in behaviors that result in access to the cell phone (Laraway et al., 2003). If fixed-time access to cell phones acted as an AO, the rate of cell phone use would be lower following the break, but data were higher immediately, and overall, following the break. An AO manipulation will be less effective if cell phones function as generalized conditioned reinforcers. Students in other studies have reported using phones in class for a variety of reasons including (a) to stay connected, (b) to stave off boredom, or (c) for entertainment (McCoy, 2013). In other words, cell phones provide access to a wide range of reinforcers. According to Skinner (1953, p. 77–79), generalized conditioned reinforcers are effective when an object is paired with more than one primary or conditioned reinforcer. It is possible that some of the weakness in the effect we observed in the treatment resulted from the difficulty to diminish the motivating operation for a generalized conditioned reinforcer. If a reduction in cell phone use came after the break that would provide evidence that the technology break acted as an AO. Because the reduction in cell phone use came before the technology break it is likely due to verbal mediation or rule-following.

There are a few additional limitations of the present study that merit mention. Our data collection system did not differentiate between academic and non-academic cell phone use. For example, a student may have used their phone to review an unknown term and it would be counted as cell phone use. Given the number of students in class and difficulty collecting data on a medium size class it was not possible to determine the type of cell phone use students were engaging in (a fairly close proximity would be required to do so). Secondly, we do not know students' typical rates of cellphone use outside of the classroom, so breaks were not calculated accordingly. Our breaks may not be frequent enough to reduce use, especially if students access their cell phones more frequently than every 15 min.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

The studies involving humans were approved by Human Subjects Committee, Southern Illinois University. The studies were conducted in accordance with the local legislation and institutional requirements. The Ethics Committee/institutional review board waived the requirement of written informed consent for participation from the participants or the participants' legal guardians/next of kin because the study evaluated a typical classroom procedure (therefore, informed consent was not required).

## Author contributions

RR: Writing – original draft, Writing – review & editing. CH-P: Writing – original draft, Writing – review & editing. JC: Writing – original draft, Writing – review & editing. LS: Writing – original draft, Writing – review & editing. EJ: Writing – review & editing, Conceptualization, Data curation, Formal analysis, Project administration.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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