Electronic Device Bans and Academic Performance: New York City Public Schools

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1. Introduction

The formation of human capital is a main determinant of labor productivity in modern economies (Blanchard 2013, 244). Human capital is developed in two primary capacities: on-the-job training and formal education (Becker 2009, 245). Formal education consists largely of verbal and written instruction in school classrooms – recent evidence suggests that in the period 1990-2014, a 1% rise in length of secondary school instruction resulted in a 0.83% growth in labor productivity (Kocourek and Nedomlelová 2018).

However, there is cause for concern that aspects of modern technology are impeding students from maximizing their time in the classroom. Of these concerns, electronic device use is quickly rising in scrutiny (Jacobsen 2011). With widespread use among students in secondary schools across the United States, it is reported that of the students who bring their phones to school, 43% admit to texting in class on a daily basis (Lenhart 2010). Coincidently, students are found to use electronic devices primarily for leisure and entertainment purposes (Lepp and Li 2015). In doing so, students forgo time spent learning, experience distractions, and engage less deeply with teaching material (Kuznekoff and Titsworth 2013). Two proposed mechanisms for these effects on classroom learning are multitasking and cognitive overload (Wentworth and Middleton 2014).

Recent literature has demonstrated the quantitative effect of classroom device use on academic performance. Carter et al. (2017) performs a randomized trial on laptop use in university lectures and finds that allowing laptop use in lectures resulted in a reduction of final exam scores by .18 standard deviations. Similarly, Patterson and Patterson (2017) finds that laptop use in college lectures reduced student course grades by between 0.14 and 0.37 grade points. In a controlled experiment, Kuznekoff et al. (2015) finds that students who abstained from using their smartphone in a lecture setting scored between 57-70% higher on an information recall test. This evidence suggests that device use within the classroom significantly affects academic performance, and in turn the growth of human capital.

In response to this research, some educational policymakers have implemented bans on electronic devices – the French National Assembly placed a ban on mobile phones in primary and middle schools in March 2018 (Loi n° 698). In an analysis of cell phone bans and academic performance in English secondary schools, Beland and Murphy (2016) find that students' national GCSE scores significantly improve following the implementation of a device ban in their school.

This paper measures the impact of the New York City Department of Education lifting their electronic device ban on school academic performance. In consequence of studying the lifting of the device ban, I estimate the effect of the introduction of unstructured electronic device use on academic performance. A quasi-experimental interrupted time series analysis is employed to determine if school state exam passing rates were significantly affected by the lifting of the ban. This paper is unique in that it only includes schools that implemented permanent metal detectors prior to the start of the study – this ensures the ban was strictly enforced. I find that the lifting of the device ban had no significant effect on school academic performance. However, there are key limitations to the analysis that educational policymakers should note in their reading of this paper. The paper proceeds as follows. The next section provides a summary of the previous literature on electronic device use and academic performance. Section three discusses background information on this case. The fourth and fifth sections describe the data and empirical strategy used in this study. The sixth and seventh sections present the results and discussion, with the final section putting forth a conclusion.

2. Literature Review

There is a limited body of literature studying the effects of electronic device bans in schools on academic performance. This is explained by the lack of centralized bans on electronic devices and the sudden adoption of mobile devices. Beland and Murphy (2016) exploit differences in the timing of implementation of cell phone bans in English secondary schools to study the effects on individual-level national exam scores. Controlling for student demographics and prior academic performance, they find students' national exam scores significantly increased post cell phone ban, by about .07 standard deviations on average. This improvement is primarily attributed to low-performing students, who gained a .14 standard deviation in exam scores. It should be noted that high-performing students' exam scores did not significantly change with the implementation of cell phone bans.

While Beland and Murphy employ rigorous empirical methods, their study is limited in that they rely on school administrator responses for cell phone policies and their level of enforcement. My empirical approach compliments their findings in that the electronic device ban being researched was strictly enforced – the schools included in my study implemented permanent metal detectors prior to start of the study, which prevented students from bringing their electronic devices to school (Mukherjee 2007).

Despite the lack of research on electronic device bans, there is a growing literature on off-task electronic device use in lectures and its impact on academic performance. Carter et al. (2017) studies West Point students in courses that permit laptop use in lectures and those that do not. The authors report that students in courses that allow laptop use had a significant reduction in final grade point by 1.8 standard deviations – which equates to a 1.7 point difference on a 100 grade point scale. Building on this research, Patterson and Patterson (2018) exploit differences in course policies to compare individual students' performance in courses that allow laptop use in lectures and those that do not. They find that laptop use decreases course grades by between 0.14 and 0.37 points – it should be noted that low-performing and male students were most negatively affected by laptop use in lectures. In a controlled experiment, Kuznekoff et. al (2015) observes that students who used their smartphone in a lecture-setting scored 10-17% worse on a multiple-choice exam given on the lecture material. After controlling for prior performance and class attendance, Fried (2008) finds that self-reported student laptop use in lecture predicted a .179 worse grade point in an introductory psychology course. Using a program that monitored student laptop activity, Kraushaar and Novak (2010) reports that in a college course, a student's ratio of distractive to productive laptop browsing windows was significantly negatively associated with final course performance by a -.362 correlation coefficient.

These studies are supported by the larger base of research focused on the relationship between aggregate electronic device use and academic outcomes. Kates et al. (2018) meta analyzes the extent to which mobile phone use affects academic performance across 39 independent studies, including 148,883 primary school through undergraduate students, and finds a significant negative relationship indicated by a 0.16 correlation coefficient. The authors caution the interpretation of their results, as the relationship effect size is small, even by educational literature standards. Baert et al. (2018) provides causal estimates supporting the negative relationship between total mobile phone use and academic performance. Using an instrumental variable technique, they find that a one standard deviation increase in daily mobile phone use decreased average exam scores by approximately one point out of twenty.

The psychological literature cites multitasking and cognitive overload as the causal links between electronic device use and poorer academic performance (Mayer and Moreno 2003). Multitasking is commonly defined as non-sequential task-switching – which has been shown to increase cognitive load (Wentworth and Middleton 2014; Ophir 2009). Empirical evidence supports these findings – Smith (2011) finds that cell phone and text message distractions significantly lowered the recognition of true answers on a verbal true-false assessment. Zhang (2015) finds that multitasking through using a laptop in college lectures had a significant negative influence on course midterm grades.

The reviewed literature provides both correlative and causal estimates for the negative effect of electronic device use on academic performance. Despite the empirical limitations of my paper, I do not find a conflicting estimate for the impact of the lifting of the New York City Department of Education's electronic device ban on academic performance.

3. Background

The explicit prohibition of electronic devices by the New York City Department of Education was implemented in September 2005, with the enactment of the 'Security in Schools' Chancellor's Regulation A-412. This regulation banned cell phones, iPods, beepers and other communication devices on school property for all New York City public schools (NYCDOE 2005).

Regulation A-412 also strengthened security measures by putting in place metal detectors at the entrances of many public schools. Due to the device ban and metal detectors, many students chose to leave their devices at home or pay corner stores to hold them until the end of the school day (The Associated Press 2012). This set of policies provides a unique situation whereby I study an electronic device ban that was strictly enforced.

Regulation A-412 was met with resistance from parents and advocacy groups, such as the New York Civil Liberties Union – they cited the need for students to communicate with their parents as justification for repealing the regulation (Mukherjee 2007). In February 2015, Chancellor's Regulation A-413 was enacted to address these objections and lifted the ban on electronic devices within schools. Regulation A-413 stipulated that school principals must establish a new electronic device policy that followed two conditions: schools must allow students to bring electronic devices onto their property, and no device can be used during exams (NYCDOE 2015).

The metric of academic performance measured in this paper is the school-level passing rate of state exams. The organization that administers New York State exams is the Board of Regents. These 'Regents exams' are standardized, cumulative assessments of student knowledge in a particular subject – Regents exams are taken at the culmination of a year-long course in the subject. Students are required to pass four exams to graduate with a Regents diploma, with at least one exam needing to be in English Language Arts, Math, Science, and Social Studies. A passing Regents score is 65 out of 100, with 55 being the passing score for students with a disability. However, the Regents score does not indicate the percentage of questions that the student answered correctly – the score indicates the number of points earned according to the New York State Learning Standards scale. New York State teachers create this scale by field-testing potential questions for each Regents exam and allocating a certain amount of points based on the difficulty of each question. These questions are then set into a final exam, with a complete 0-100 score range (NYSED OSA 2005). This allows for Regents scores to be compared across exams and academic performance to be assessed over time.

4. Data

The New York State Education Department publishes publicly available data on all public schools in New York State. Using this administrative data, I create a panel dataset of Regents exam passing rates for each sampled school over the period 2007 to 2017. There are four fundamental variables included in this panel dataset: exam passing rate, exam year, exam subject, and school. Each observation consists of a school's passing rate for an exam in a specific year.

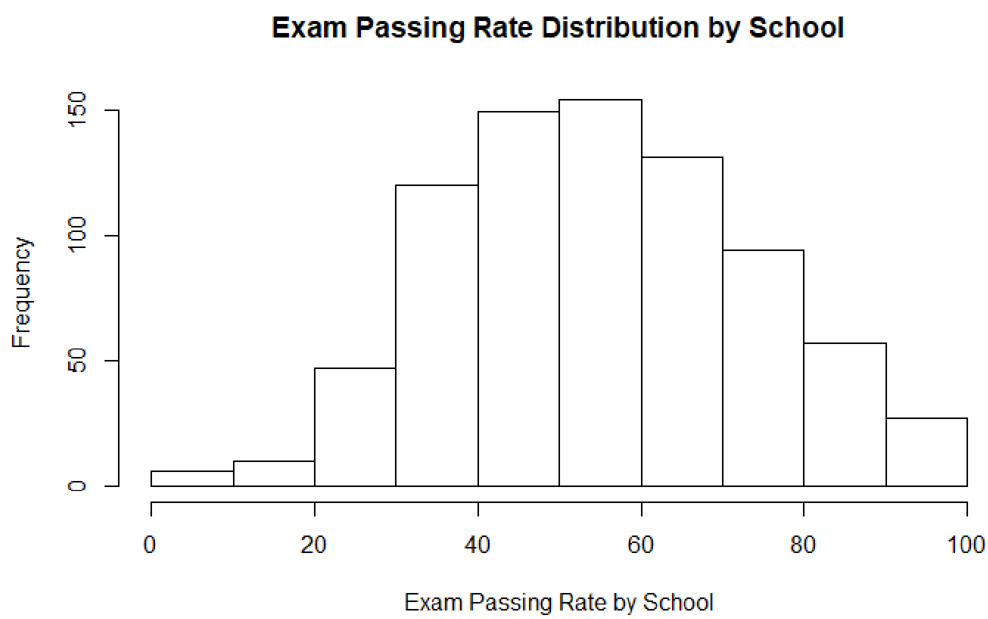
Students designated with special education needs status were excluded from this sample – this decision was made to standardize the passing rate for all students in the sample. This is a limitation of the external validity of the study, as there are approximately 150,000 special education needs students enrolled in New York State public secondary schools (NYSED IRS 2018).

The two Regents exam subjects included in this sample are Living Environment (Biology) and Global History/Geography. This decision was made to standardize subject curriculum and attain the largest sample size of students tested. Regents exams in Math and English Language Arts transitioned to Common Core standards over the course of the study, and as a result, only subjects in Science and Social Studies are appropriate for this analysis. Living Environment and Global History/Geography are the first courses taken by secondary school students in the Science and Social Studies tracks. Consequently, these subjects consistently have a higher number of students taking exams – 197,089 student exam scores were included in this sample.

There are 67 New York City public secondary schools that were included in this sample – these schools were chosen because they implemented permanent metal detectors prior to the start of the study (Mukherjee 2007). However, I recognize that the sampling of these schools contributes to limitations of the validity of the analysis. These schools may have implemented metal detectors because they had higher rates of crime, which may indicate they are not representative of all New York City public secondary schools.

A key limitation of this sample is that it does not include schools that were shut down due to poor performance. Of the 87 schools with permanent metal detectors implemented prior to the start of the study, 20 of these schools were shut down due to poor performance by 2017. This results in a significant bias in the sample, whereby only schools who improved exam performance, or kept high performance throughout, were included in the sample. This bias is represented in the skewed distribution show in Figure 1.

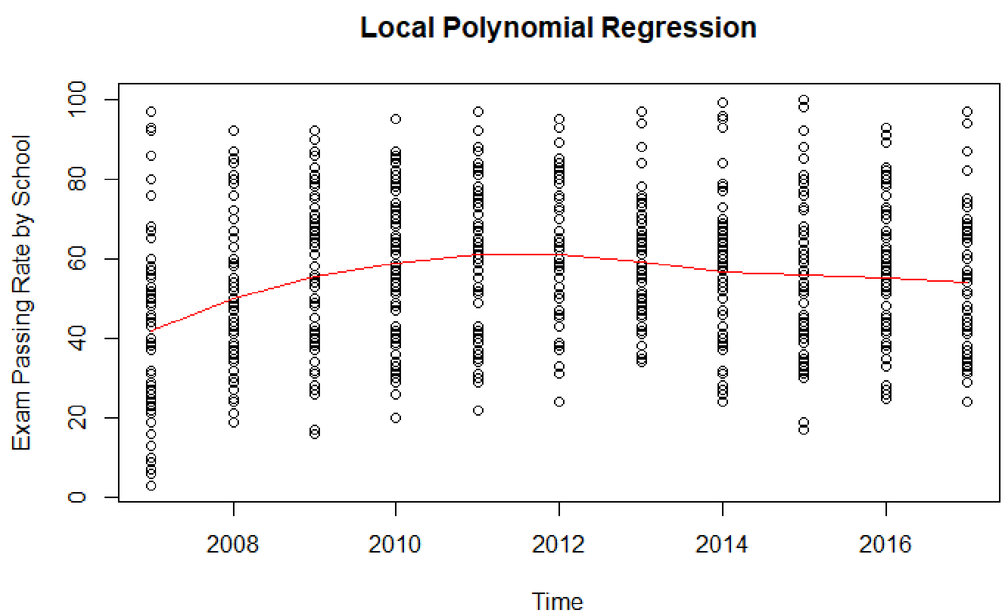
Figure 1



Notes: Passing rate for each school included in the study for each exam given each year. The distribution is skewed towards high exam scores – this is in part due to the exclusion of schools that were shut down due to poor performance over the period of the study. n=795.

The mean passing rate for all 795 observations is 55.36. Figure 2 is a local polynomial regression that illustrates the general trend in school passing rates over the period of the study. There appears to be a slight upward trend in passing rates prior to 2012, an inflection point in 2012, and a slight downward trend thereafter.

Figure 2



Notes: Locally estimated scatterplot smoother (LOESS) for the 795 observations in the study.

5. Empirical Strategy

I estimate the effect of the New York City Department of Education lifting their electronic device ban on school academic performance using the quasi experimental approach of interrupted time series analysis:

(1) $$Y_{st} = \beta_0 + \beta_1 T + \beta_2 Lift_{st} + \beta_3 T \times Lift_{st} + \varepsilon_{st}$$

where Y_{st} is the percentage of students passing the Regents exam at school s in year t. T is the time in years since the beginning of the study. $Lift_{st}$ is an indicator variable that differentiates ban and post ban time periods. $T \times Lift_{st}$ is an interaction term that indicates the time in years since the lifting of the ban. ε_{st} is an error term representing the variability unexplained by the model. β_0 is the conditional expected value of Y_{st} for all schools at the beginning of the study. β_1 is the change in Y_{st} predicted by a time unit increase, prior to the lifting of the ban. β_2 is the magnitude of level change immediately following the lifting of the ban. β_3 is the difference in the slope of Y_{st} before and after the lifting of the ban – β_3 estimates the long-term impact of lifting the ban (Lopez et al. 2016; Linden 2015).

A well-known complication of time series analysis is the serial correlation of the error terms over time – this is referred to as autocorrelation. To attain robust standard errors and eliminate autocorrelation, I implement Newey-West estimators (Linden 2015).

6. Results

Table 1 presents estimates of the interrupted time series analysis, which measured the effect of the lifting of the electronic device ban on academic performance. The intercept passing rate (β_0) is estimated to be significant at 50.08. A one unit increase in time is estimated to increase the passing rate by 1.41 points, prior to the lifting of the ban – this term (T) is also significant. The lifting of the ban induces a 32.36 magnitude level change, however, this term ($Lift_{st}$) is not significant. The difference in slope before and after the ban is negative at -4.29, however, this term (β_3) is also not significant. The residual standard error is 18.39, and the R^2 value is 0.032.

Table 1

Term	Estimate	Std. Error	p-value
Intercept	50.08	1.28	2.20e-16***
Time	1.41	.28	6.18e-07***
Lift	32.26	30.36	.29
Time*Lift	-4.29	3.20	.18

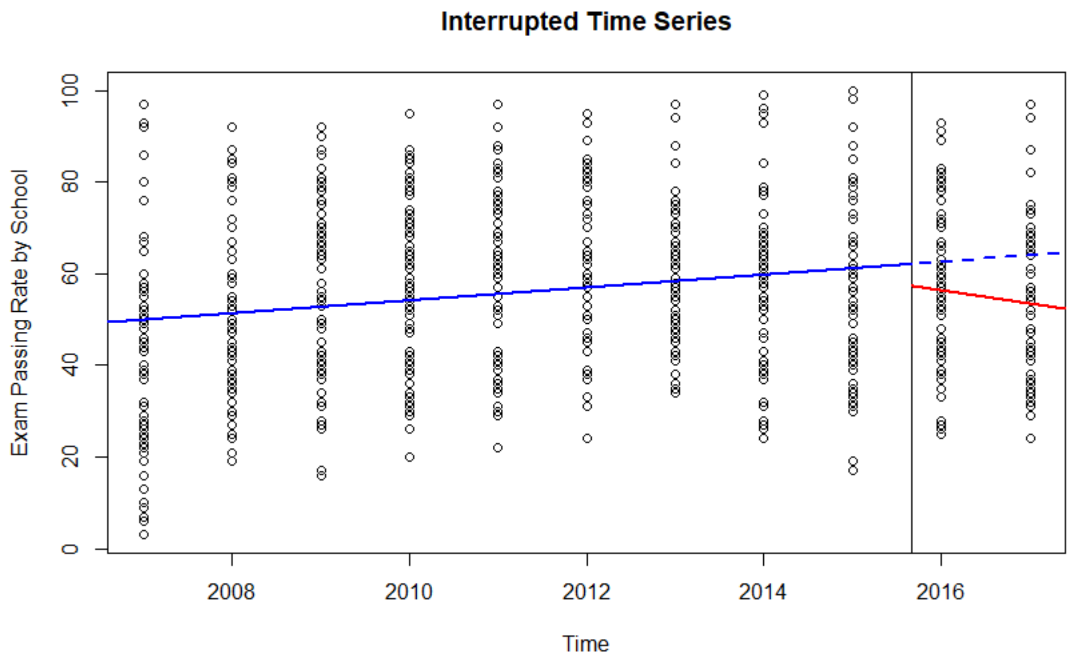
*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Figure 3 is a graphical representation of the interrupted time series analysis. The model shows a slightly positive sloping regression line prior to the lifting of the ban, a small negative level change due to the ban, and a negative sloping regression line following the lifting of the ban.

Figure 3



7. Discussion

The analysis does not support the hypothesis that the introduction of unstructured electronic device use in schools, due to the lifting of the device ban, negatively affects academic performance. Although the findings of this analysis do not conflict with prior research, non-significant estimates for the effect of the lifting of the device ban do not reinforce the evidence that device use is negatively associated with academic performance. I attribute the lack of statistically significant results to two characteristics of the sample. First, the large residual standard error of 18.39 – this is indicated by the large conditional standard deviation of the sample shown in Figure 3. Second, the small sample size of 137 observations following the lifting of the ban.

However, there are key limitations to this analysis that should be noted in the interpretation of these results. As noted above, 20 schools were excluded from this sample due to being shut down for poor performance. The exclusion of these schools is assumed to bias these results – this is of particular importance because prior research shows low-performing students are most negatively impacted by device use (Beland and Murphy 2017). The analysis does not account for other educational policies put in place over the period of the study – these policies may be confounding factors on Regents exam passing rates. The analysis does not include fixed effects to account for the same schools being sampled over time – this may violate the interrupted time series analysis assumption of conditional independence. Lastly, using school-level passing rates limits the analysis in identifying students who take an exam multiple times

– this may bias the results towards lower exam scores, as students who fail the exam are expected to retake it to obtain a Regents diploma.

8. Conclusion

This paper examines the effect of the New York City Department of Education lifting their electronic device ban on school academic performance. Previous literature provides evidence of a positive impact of implementing electronic device bans on individual academic performance. Prior research also presents correlative and causal estimates for the negative relationship between electronic device use in a lecture setting and academic performance. Both strands of literature cite multitasking and cognitive overload as mechanisms of poorer academic performance due to device use. I leverage publicly available administrative data published by the New York State Education Department to create a panel dataset – the metric used to assess academic performance is the passing rate of state exams at the school level. Interrupted time series analysis is employed to generate estimates of the impact of the lifting of the device ban. I find no significant negative effect of the lifting of the electronic device ban on school academic performance. However, key limitations of the study should be noted in the reading of this paper. Further research should be performed, ideally at the student level, to more rigorously explore the effects of the lifting of the New York City Department of Education's electronic device ban.

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