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Use of Technology in the Classroom and Students' Outcomes

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Abstract

Each year, technology becomes increasingly integrated into the classroom. In the present day, students use a plethora of electronic devices to assist them in their studies. However, there is a popular and ongoing debate whether technology improves student performance or if it is a detriment instead. For this study, two sections of economics classes at Anderson University were analyzed. Section two allowed unlimited access to technology in the classroom, while section three was not allowed to use technology in any capacity. Data such as student SAT score, GPA, attendance, student job or lack thereof, student extracurricular sports or lack thereof, household income, student religion, and professor and class evaluations were collected from both sections. Once data was entered, tests performed show a statistically significant difference in overall grade between two sections. Students do better, on average, when technology is not allowed in the classroom.

1. Literature Review

Literature reviews on the topic of usage of technology in the classroom in higher education are very mixed at best. Most colleges and universities are not only allowing, but also promoting the use of lap-tops, tablets, personal phones as complements to active learning, lectures and student-centered learning strategies. In many cases, students are required to download certain apps, so that they can participate in classroom lectures and discussions. Some students use their computers/phones as substitutes for their notebooks. Some use their computers/phones to open their e-books as substitutes for hard-copy texts. Survey evidence from 2006 suggests that students enjoy having computers in the classroom [1].

On the other hand, technology can be used for leisure purposes during the class, which does cause negative externalities. Fried finds that students report increased multitasking when laptops are in the classroom [2]. Kraushaar and Novak and Grace-Martin and Gay, monitor activity usage and find negative correlation between non-class related activity on their computer and performance [3,4].

Relatedly, multiple laboratory-style studies demonstrate negative effects of laptop multi-tasking on test performance [5,6]. While distractions and multi-tasking are one potential channel through which computers may negatively impact performance, another potential channel is that students recall less information when they are required to take notes with computers rather than by hand, as suggested in a lab experiment by Mueller and Oppenheimer [7]. Carter at al. conducted a study at the US Military Academy, where they compared the final exam scores among two separate groups of students taking the same course [8].

Students in the class where computers were allowed scored less than the students in the classroom that prohibits the use of personal computers. Average final exam scores for the class that allowed computers was 0.18 standard deviations lower than the average exam scores among students who were not allowed the use of personal computers. Beland and Murphy exploit variation in school mobile phone policies to find that banning mobile phones is associated with a 0.07 standard deviation increase in exam scores among UK high school students. Elsewhere, Patterson and Patterson analyze computer usage in classes that allow laptops with the laptop policies from students' other classes during the day and find that computer usage reduces academic performance among undergraduate students at a private liberal arts college [9,10]. Our paper's experiment complements these studies by directly investigating the potential impact of a teacher's decision to permit or restrict laptops and tablets in their classrooms.

Section 2 of this paper provides background on Anderson University for the purposes of generalization, and Section 3 discusses our experimental design. Sections 4 and 5 discuss our empirical framework, sample selection, data, and evidence of successful random assignment. Section 6 presents the results of our regression analysis, and Section 7 concludes.

2. Institution Background

Anderson University in Anderson, SC, is a 4-year undergraduate institution with an enrollment of approximately 3500 students. University also offers many graduate programs and several doctorate degrees. In addition to a mandatory sequence of general education courses, students complete a liberal arts education with required courses in math, history, Christian studies, English, philosophy, and other. Business majors have

to take introductory economics. This principles-level economics course, which combines micro and macroeconomics in a single semester, is typically taken during a sophomore year. In general, students take principles of microeconomics class during the fall semester and principles of macroeconomics the following spring semester. Due to school's undergraduate growth, there are now four sections of principles. This study was done between two different sections of the same class.

3. Methodology

Section 2 was allowed unlimited access to technology in the classroom, while section 3 was not allowed to use technology in any capacity. Section 2 students were allowed to bring and use their phones and computers. Section 3 students were allowed to bring only their notebook and a calculator. Section 2 was a treatment group. Section 3 was a control group. In order to check for the homogeneity of both sections, I ran a t-test 2 sample mean scores on variables SAT, GPA, HH Income, Work and Sports. These independent variables should have a significant impact on students' overall grade in the class. SAT represents the entrance exam taken by students prior to going to college and it is used by admissions offices to evaluate candidate's abilities, mainly in math and English. Based on academic literature, SAT scores are good predictors of students' success in the first year of college. GPA is a measure of students' class performance, while in school. Higher grades lead to a higher GPA. Both variables, SAT scores and GPA can lead to a larger scholarship as well. HH Income represents household incomes, which is a proxy variable for parents' education level, or to some degree parents care for their children education. Work and Sport are two variables that we collected via survey by asking (1) while in college, do you work (full time or part time), and (2) do you participate in college sports at the varsity level. Anderson University competes in the NCAA Division II league and offers many different sports for female and male athletes.

Results show no statistically significant difference between the means of these 5 variables. Thus, we have well randomized classrooms and results should not give us biased outcomes.

	attendance final grade	Final grade	Class evaluations	Professor evaluations
mean	84.45	81.9	4.31	3.70
Std Dev	26.37	13.05	0.71	0.81
min	0	32.19	3	2
max	100	94.92	5	5
N	29	29	29	29

	SAT	GPA	HH Income	Work	Sport	Faith	Econ Pre-req
Mean	1140.68	4.48	0.45	0.55	0.31	0.97	1
Std dev	160	0.63	0.51	0.51	0.47	0.19	0.2
Min	500	2.5	0	0	0	0	0
Max	1420	3.7	1	1	1	1	1
N	29	29	29	29	29	29	29

Table: 1 descriptive statistic for given variables for section 2 class. Class evaluations were specific students' evaluations with respect to the class and faculty evaluations specifically addressed faculty's skill set. Variables Work, Sport, Faith and Economics Prerequisite are dummy variables, with 1=yes and 0=no.

	ATG	FG	CE	PE	SAT	GPA	HHI	W	S	F	PR
Mean	91.15	85.15	4.25	3.79	1154.82	3.24	0.59	0.74	0.19	0.96	0.96
SD	17.57	7.3	0.62	0.97	120.75	0.68	0.65	0.45	0.39	0.19	0.19
Min	15	71.15	3	2	940	1	0	0	0	0	0
max	100	98.14	5	5	1400	4	1	1	1	1	1
N	27	27	27	27	27	27	27	27	27	27	27

Table: 2 Descriptive statistics for section 3 variables; same variables as in section 2 are listed.

Section 2 had 23 male and 8 female students. Section 3 had 19 male and 8 female students. I ran t-Test 2-sample assuming unequal variance on the following variables: SAT score, GPA, HH Income, Work and Sports. In each case (variable) there was no statistically significant difference in those variables between the two sections. This gives us more reliable results, not influenced by one group of students superior to another. Proof of randomness.

4.Results by Section

Section 2, again, was the treatment group. Students in this section were allowed to come into the classroom with any technology they preferred. Here are the regression results for the section 2 class. The dependent variable was students' final course grade.

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	4.31006452	17.89364865	0.240871	0.812235
Class Evals	2.04748199	2.964766954	0.690605	0.498165
Prof Evals	-0.0822555	3.78778059	-0.02172	0.982901
SAT Score	0.02008563	0.010678017	1.881027	0.075384
GPA	0.09466978	0.417046864	0.227	0.822848
HH Income	7.29836539	4.78175604	1.526294	0.143412
Work	1.40186687	4.297296149	0.326221	0.747823
Sports	-9.6157933	3.879731119	-2.47847	0.022748
Faith	14.5000551	11.39061888	1.272982	0.218381
Attendance Final Score	0.36293639	0.07015296	5.173501	5.4E-05

R Square	0.73862673
Adjusted R Square	0.61481834

F	*Significance F*
5.965886	0.000536851

Table 3: Regression results for section 2

F-test suggests that our model is strong. Individually, variables Sports and Attendance are significant at 95% level of significance. SAT score variable is marginally significant. For every additional 1-point attendance score, the student's grade increases by 0.36 points. Both variables are based on a 100-point scale. If a student participates in varsity sports, class grades decrease by 9.6 points. This is almost a full letter grade.

Section 3 was the control group. This section allowed only a notebook and a pen/pencil. This group was also given an option to complete the assignment Learn Smart (LS) on a weekly basis, while it was required in section 2. Learn Smart is an algorithmic based activity, where students are expected to answer the questions with a certain degree of confidence. If they cannot, the system takes them to the e-book where they can learn the material. Doing the LS, one should expect, will have a positive impact on the class grade.

	Coefficients	Standard Error	t Stat	P-value
Intercept	20.56983907	23.99930114	0.857102	0.404874821
Class Evals	0.126421711	2.254615333	0.056072	0.956024207
Prof Evals	1.153145496	1.465597664	0.786809	0.443647901
SAT Score	0.022915904	0.013815511	1.658708	0.117932862
GPA	2.84339451	3.419742682	0.831464	0.418751087
HH Income	2.433629366	2.547146944	0.955433	0.354504131
Work	-0.695309866	2.64029855	-0.26335	0.795867696
Sports	3.23784456	3.464809457	0.934494	0.364849818
Faith	-8.112743502	10.7677195	-0.75343	0.462853294
Econ pre-req	4.094719256	6.904719328	0.593032	0.561995172
LS %	0.07690053	0.034308151	**2.241465**	0.04054699
Attendance Final Score	0.256580831	0.080444899	**3.189523**	0.006093147

R Square	0.651804443
Adjusted R Square	**0.396461035**

F	Significance F
2.552658191	0.046832973

Table 4: Regression results for section 3

Looking at the F-test, the model for section 3 is jointly significant at the 5% level of significance. LS% (learn smart) variable and Attendance are significant and affect overall grade in a positive way. LS% was a percentage score student earned on the assignment, which was optional in section 3. Students who did it would improve their overall grade by 7% or 7 points. Also, for an additional 1 point in attendance, the overall grade increases by 0.3 points. It pays to do Learn Smart and come to class.

5. Combined Sections Results

This paper's hypothesis is that there is a statistically significant difference in the performance between these two sections. Comparing the individual performance variables among two sections, like a final test grade, or a final grade on the homework did not yield significant results. One of the problems here is that the data sets are too small and can't give us a more significant result. However, when all of the final assignments from ST2 are combined and tested against all of the assignments from ST3, the differences in the results are significant.

t-Test: Two-Sample Assuming Unequal Variances			
	st2	st3	
Mean	**78.2702069**	**84.185**	
Variance	365.7319604	268.0931	
Observations	145	162	
Hypothesized Mea	0		
df	285		
t Stat	**-2.893994434**		
P(T<=t) one-tail	0.002048779		
t Critical one-tail	1.650217713		
P(T<=t) two-tail	**0.004097557**		
t Critical two-tail	**1.968322603**		

Table 5: t-Test: two-sample assuming unequal variances

Table 5 shows the difference in the mean overall scores between two sections. Students in section 3 score, on average, 6 points more than section 2 students, or about 7.6% better. Based on t-test and p-value, the difference is significant.

Anova: Single Factor						
SUMMARY						
Groups	Count	Sum	Average	Variance		
st2	145	11349.18	78.27021	365.732		
st3	162	13637.97	84.185	268.0931		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	2676.848282	1	2676.848	**8.5198**	**0.003774**	3.872128
Within Groups	95828.39554	305	314.1915			
Total	98505.24383	306				

Table 6: Anova Single Factor

Table 6 shows the results of the Anova, Single Factor output. Sections 2 and section 3 means and variances are compared and based on the F-test and the p-value, there is a significant difference between the two.

Regression Statistics									
Multiple R	0.164847439								
R Square	0.027174678								
Adjusted R Square	0.023985087								
Standard Error	17.7254467								
Observations	307								
ANOVA									
	df	SS	MS	F	Significance F				
Regression	1	2676.848	2676.848282	**8.519799599**	**0.003774481**				
Residual	305	95828.4	314.1914608						
Total	306	98505.24							
	Coefficients	Standard E	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.(	Upper 95.0%	
Intercept	84.185	1.392643	60.44982317	7.9001E-172	81.44459636	86.9254	81.4446	86.9254	
dummy	**-5.914793103**	2.026399	**-2.918869575**	**0.003774481**	-9.902284168	-1.9273	-9.90228	-1.9273	

Table 7: Regression with Dummy Variable

Table 7 presents the regression analysis using dummy technology variable. One was assigned for students in section 2 and zero for section 3. In other words, dummy of 1 reflects the use of technology, while dummy of 0 reflects no use of the technology. Students who were allowed to use the technology during the class scored about 6 less points on the course final grade. Looking at t-test and the p-value, this estimate is significant.

6. Conclusion

This paper tries to address the use of technology in the classroom and its outcome on students' performance. Students can use their laptops, I Pods, phones etc. to enhance their education, and many do. However, these devices also provide all sorts of sites that take students' attention away from the classroom work. This paper uses the data provided by two different sections of the same economics classes, in which one class was allowed the use of technology during the class time, while the other was not. When all the assignments final grades were aggregated and compared between two sections, results show a significant grade difference between two sections. Using t-test of 2 variables with unequal variances, students in section 3 class (no technology) performed above section 2 class by full 5.92 points, or by about 7.6% points. Anova method supports that conclusion, and so does our last regression using the Dummy variable.

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