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Does Knowing a Study's Outcome Further Impact It's Conclusion: A Classroom Study

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Abstract

Recently, authors from West Point and MIT wrote about the impact of varied computer usage on student performance in an Economics class[1]. The study demonstrated that students perform more poorly when allowed to use computers in the classroom. The current article takes this conclusion one step further using an Engineering Economics class. Would students who were not allowed electronics in the classroom and also informed about this West Point/MIT study perform differently than students who were simply not allowed to use computers in the classroom? It is hypothesized that students who are informed about the West Point/MIT study and its' outcome and not allowed to use computers will perform better than those who are simply prohibited from the use of computers in the classroom.

Introduction

Internet usage in the educational arena has grown enormously over the past three decades. Back in the late 1980's and early 1990's, burgeoning Intranets were popping up on college campuses. Internet accessibility outside of the classroom and in dormitories, etc. soon followed. Today, access to WiFi is something college campuses must have as they are "graded on" it in many cases: the more Internet availability and better student access, the better the grades.[2,3] Given the expansion of Internet accessibility and usage of electronic wireless devices, the natural progression is the use of such technology in the enhancement of education over those same decades.

In the later portion of the 20th century into the early 2000's, it was popular opinion that the use of technology would enhance the classroom and boost student learning. By the 2000's however, opinion was mixed. Johnson[4], for example, found that there was no difference in performance between students who used computers more or less often, holding computer familiarity of the instructor constant. Conversely, Kmitta and Davis[5] found that computer use has a "positive effect" on student performance. Meanwhile, a global study by the Organization for Economic Cooperation and Development examined the impact of technology on international test results and found those countries that had invested heavily in technology in their school systems have seen "no noticeable improvement" in their test scores (Coughlan[6]).

So the question remains, does technology always enhance education? In order to get a more accurate answer, studies began parsing the groups within the data sets. For example, Wainer, et. al. looked at computer use and internet access in relation to academic success and parsed the data by socio-economic status to find what some might call interesting conclusions: internet use is bad for your grades if you are "young and poor"[7]. But is this the only way to analyze what is happening in the classroom when technology's effectiveness is being assessed? According to researchers at MIT and West Point, the answer is, “no”. Their study, published in May of 2016, involved over 725 students in three treatment modes: no computer usage allowed by the student, unlimited computer usage by the student, and usage where the tablet is limited to being kept on the desktop. This study analyzed just one course in one single academic term taught the same way with the same materials and rubrics in different sections, but using the three varied computer modes just outlined as comparisons. The study found that student academic achievement was better in the mode when technology was not allowed in the classroom.

The above referenced study took place at West Point. However, West Point is not like a traditional college campus, and some might even call it unique. As such, some may say that the findings of the West Point/MIT study might not apply to the generalized college environment. However, the authors of the West Point/MIT study note that findings would probably be far worse on an average campus as West Point cadets are highly motivated to earn high grades and West Point class sizes are normally small with professors expected to interact with students during every lesson.

Population

The current study takes place at Stevens Institute of Technology, a small, private, urban campus across the Hudson River from Manhattan in New Jersey. Approximately 3000 undergraduate students are enrolled, of whom about 2000 are engineering students. The Engineering Management Program housed in the School of Systems and Enterprises at Stevens has been ABET accredited since the early 1990’s and has been responsible for teaching the junior level Engineering Economics course at Stevens for decades.

Course Design and Instruction

The Engineering Economics course is part of Stevens Institute Of Technology’s “core” engineering curriculum. As such it has a high enrollment: approximately 130 in the fall, 300 in the spring and 50 in the summer. The Engineering Economics course is a four-credit course comprised of three credits of “course” and one credit of “lab”. For the purposes of this study only the course classroom was affected. The lab portion, as could be imagined, mandated computer use in the classroom, as well as, computerized submissions of all assignments and as such, the modification of student usage of electronics was not applied to the lab portion of the course.

The same professor teaches all of the sections of Engineering Economics throughout the year. Additionally, this professor has been teaching the course for 15 years and thus has much experience with the topic. The professor revamped the course in the fall of 2013 and has been using the same materials, syllabus and textbook in every section since this time. All Stevens’ students are on equal footing in regard to computer access and knowledge as Stevens Institute of Technology requires all of its students to purchase a computer upon entry. Additionally, all academic buildings, dormitories and campus public spaces are equipped with wireless Internet access. Lastly, all engineers are required to complete an introductory programing course during their freshman year, between two and four semesters before the students enroll in the Engineering Economics course. As such, it can be said that the student population is quite familiar with computers and Internetbased electronics.

Sample Data and Methodology

The sample in this study consists of students enrolled in Stevens Institute of Technology Engineering Economics course during the fall semester of 2015 contrasted with those from the fall semester of 2016. Those students in the fall 2015 group were simply told that computers were not allowed in the classroom. Those in the fall of 2016 group were also told that computers were not allowed in the classroom, but in addition were told about the MIT/West Point study at least seven separate times over the course of the semester. Fall semester vs. fall semester data was used instead of spring semester data due to the difference in size of the data sets in the second group. Such a size difference could potentially indicate a change in the student body composition of the fall vs. the spring semesters. The sample consisted almost entirely of students in their 5^{th} or 6^{th} semesters. (Due to the Stevens co-op program, some students could be in a semester other than $5^{th.}$) This resulted in a sample of 117 from Fall 2015 and 144 students in Fall 2016 for a total of 261 students. The racial and ethnic composition of the students was considered consistent with Stevens as a whole since every engineer has to take the Engineering Economics course. As such, it was assumed that there was very little difference between the populations for the two semesters.

A final exam was mandatory for all students in the course. All exams consisted of mostly mathematical questions with only about 10% of each test in multiple choice or fill in the blank format. Given that the answers to both of these types of questions are either right or wrong and that about 5 different people grade the exams, instructor bias should not be considered an issue (graders grade separate problems, so the grading of each problem can be consistent across all students, and graders were not made aware of this study). Additionally, given that the same instructor taught all sections, there are no idiosyncratic grading procedures that were applied to only one of the data sets.

The analysis was completed comparing the final exam and course scores of the Fall 2015 students (those who were just told that electronics were not allowed in the classroom) to the final exam and course scores (respectively) of students from the Fall of 2016 (those who were told electronics were not allowed since studies show use of electronics in the classroom negatively impacts grades). These two grades were chosen intentionally. The final exam score was chosen since it reflects how well students understand the material from the entire course (but does not include the grades from the lab portion of the course). The course score was chosen for contrast since this score reflects both the course portion (where the study took place) and the lab portion of the course.

Data Analysis

The two different hypotheses being tested are:

the difference in the means for the final exam scores for the two populations, and
the difference in the means for the overall course scores for the two populations.

Null hypothesis 1: Ho: μ final exam score 2015F = μ final exam score 2016F
Null hypothesis 2: Ho: μ overall class score 2015F = μ overall class score 2016F

The samples are assumed to be independent, and normally distributed. The variance for both populations is unknown, but we've pooled the sample variances to estimate the population parameter. We'll assume that $\sigma_1^2 = \sigma_2^2$, and select $\alpha = 0.05$.

Given $n_1 = 117$ and $n_2 = 144$, the degrees of freedom is $117 + 144 - 2 = 259$.

With $\alpha/2 = 0.025$, the critical *t* statistic is ± 1.969. (Due to the large sample sizes, the *t* statistic value is essentially equal to the Z score.)

The pooled *t* statistic is calculated by:

$$t_{sample} = \frac{(\bar{x}_1 - \bar{x}_2) - (\bar{\mu}_1 - \bar{\mu}_2)}{\sqrt{\frac{s_1^2(n_1-1) + s_2^2(n_2-1)}{n_1+n_2-2}}\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

The sample data variables were calculated to be:

	Fall 2015 Exam	Fall 2015 Course		Fall 2016 Exam	Fall 2016 Course
N	117	117		144	144
Avg	87.718	86.891		90.387	88.336
Var	190.618	81.548		59.016	60.447
Std.Dev.	13.806	9.030		7.682	7.775

Null hypothesis 1 – final exam scores:

$$t_{sample} = \frac{(\bar{x}_1 - \bar{x}_2) - (\bar{\mu}_1 - \bar{\mu}_2)}{\sqrt{\frac{s_1^2(n_1-1) + s_2^2(n_2-1)}{n_1+n_2-2}}\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} = \frac{(87.718 - 90.387) - (0)}{\sqrt{\frac{190.618(117-1) + 59.016(144-1)}{117+144-2}}\sqrt{\frac{1}{117} + \frac{1}{144}}} = -1.974$$

$$t_{critical} = -1.969$$

Since $t_{sample} > t_{critical}$, we therefore reject the null hypothesis – there appears to be a statistically-supported difference between the final exam scores of the two student populations.

Null hypothesis 2 – overall course scores:

$$t_{sample} = \frac{(\bar{x}_1 - \bar{x}_2) - (\bar{\mu}_1 - \bar{\mu}_2)}{\sqrt{\frac{s_1^2(n_1-1) + s_2^2(n_2-1)}{n_1 + n_2 - 2}}\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} = \frac{(86.891 - 88.336) - (0)}{\sqrt{\frac{81.548(117-1) + 60.447(144-1)}{117 + 144 - 2}}\sqrt{\frac{1}{117} + \frac{1}{144}}} = -1.389$$

$$t_{critical} = -1.969$$

Since $t_{sample} < t_{critical}$, we therefore fail to reject the null hypothesis – there is no statistically-supported evidence of a difference between the final course scores of the two student populations.

Results

The study compared the final exam and course scores of the Fall 2015 students (those who were only told that electronics were not allowed in the classroom) to the final exam and course scores (respectively) of students from the Fall of 2016 (those who were told electronics were not allowed since studies show use of electronics in the classroom negatively impacts grades).

The data indicates that the final exam averages between the students in different years exhibited a statistically-supported difference.

The data also indicates that the overall course averages between the students in different years did not exhibit a statistically-supported difference.

It appears that the students who were simply told they wouldn't be allowed to use electronic (rather than receiving an explanation) exhibited a slight difference in their final exam scores, but not in the overall course scores. As reminder, the final exam score was reflective of understanding of course material but did not include the grades from the lab portion of the course. The overall course score included grades from both the course and the lab (i.e. outside the purview of this study). As such, explaining why electronics are prohibited from the classroom appeared to have an effect on final exam scores, but not on overall course performance.

Conclusion and Future Directions

The results of the West Point/MIT study suggest that student use of electronic devices in the classroom has a substantial negative effect on student's academic performance. This Payne Carter, et. al.[1] study found a .28 standard deviation in final exam scores which equates to a 1.7 point reduction on a 100 point scale. The authors provide two key reasons for this difference. The first reason cited is distraction by the electronic device via the student checking email, texting, social media, surfing the Internet, or simply performing other work on the electronic device. The other key reason cited was the study by Mueller and Oppenheimer[8] who found that students are less effective at note taking skills on a computer vs. with pen and paper. The authors go on to state that their outcome is more negative than the effect of increasing class size as found by Bandiera, Larcinese and Rasul[9]. In summary, the authors conclude the data proves that student performance decreases when personal computing devices are allowed in the classroom.

This current study did not allow computers in the classroom in either treatment group. However, one group was told that the reason for the ban on technology was due to the knowledge from the West Point/MIT study that electronic devices in the classroom reduce student performance. The results of this study showed that the students perform better on tests if they are told why they are not allowed to use computers in the classroom.

The lack of difference found between the overall course grades was attributed to the fact that the overall course grade included both the course grades (within the study) and other grades (outside the study). The students final course grade included points for how they performed on tests, as well as, points for participation and student achievement in labs. In future studies, the data could be parsed to analyze performance on all the tests eliminating non-academic and laboratory factors that could affect overall course grade.

Reasons for the difference in academic success in final exam test scores between the two groups could boil down to student perception. If students feel they are not allowed to use electronic devices because they are simply “banned” from doing so, they could perceive such a “ban” as punishment and then be negative toward the class. However, if the student feels the professor is promoting a culture of care and is trying to promote student engagement and performance in the classroom by eliminating electronic devices, the student might also want to achieve better performance. There are many, many papers written about perceptions of students in the classroom influencing motivation and academic performance (See for example, Simmons[10], Gilbert, et. Al.[11] Church, et. al[12]). Many of these papers demonstrate that factors perceived inside the classroom outwardly affect student motivation and performance. As such, if computers are not allowed in the classroom, it might behoove the professor to inform students that the reason for the ban was based on research demonstrating that students will perform better academically if electronic devices are not permitted in the classroom.