Online Versus In Person Student Learning Outcomes

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Abstract

Due to the Covid-19 pandemic, many undergraduate students were forced to take courses online instead of in person. This paper discusses the student learning outcomes of some courses that have sections with both an online and in person sections. A junior level industrial engineering course showed that the in person students performed significantly better, statistically speaking. In contrast, a graduate course in an online graduate program had no statistical significant learning outcomes between the online and in person students. The paper concludes by indicating that online learning can be just as effective, but the students pursuing this option must actually desire this type of learning and be willing to perform the necessary work to succeed.

Key Words: Online Teaching, Hybrid Teaching, Active Learning, Student Assessment

1. Introduction

Spring 2020 threw both students and faculty roles into a chaotic situation. The Covid-19 pandemic swept the globe, and the majority of universities and colleges ceased in person meeting. This occurred in March and frequently coincided with spring break. Most institutions, cancelled a week of classes to let the faculty prepare to switch all of their sections to online. As a result, most spring semesters had a week less of learning outcomes. Many students struggled and a variety of institutions provided allowances that enabled students to earn a passing grade that would not impact the students' GPAs or their graduation status (increase the number of hours taken in nongraded courses). Student learning outcomes from the Spring 2020 semester are not the focus of this paper.

For the Fall 2020 semester, Kansas State University allowed faculty to teach in person or online. The students in person had to sit 6 feet apart to avoid contact tracing due to class attendance. The author opened up a section of in person for an Operations Research 1 course. This course is a junior level course and required for all BSIE students. A total of 56 students enrolled. The classroom capacity was 50. So the author opened up an online version for those that wished not to risk the pandemic. Fortunately, seven students enrolled in the online version. This allowed every in person student to attend every lecture. In contrast, many other fall 2020 classes had schedules where students could only attend lecture once a week.

The classroom had technology, so the author would present his work on a piece of paper that was then projected to two screens for the in person students to view. At the same time, video equipment captured this screen for the online students. The faculty's voice was recorded, but any student's comments were not. The faculty member tried to repeat the students' questions or comments for the online students.

The author has taught these type of hybrid courses since 2001. Kanas State University has a Masters of Operations Research degree that has had an online component since 1990. That is, he would teach students in the class and have the lecture recorded. These lectures were first mailed to the online student on a VHS tape, but are now uploaded and streamed. Thus, the author is well versed in simultaneously teaching to both online and in person students. These type of classes are frequently called hybrid courses.

This paper focuses on the learning outcomes of online and in person students in two hybrid classes. The data shows that there is insufficient evidence that the student learning outcome, as measured by the final exam, has a different mean score between online and in person students for the graduate level course. Surprisingly, the results were statistically significant and the online students performed dramatically worse than the in person students for the junior level class. In fact, not one online student received an A in this undergraduate course. This paper describes these results and discusses the need for the students to be prepared for an online experience before expecting to succeed in this learning environment.

The remainder of this paper is organized as follows. Section 2 provides some background information regarding the courses along with relevant references. The third section analyzes the student learning outcomes, presents the statistical analysis and draws some conclusions. Section 4 summarizes the paper and provides some areas for future research.

2. Background Information

The importance of quality in person and online instruction has led to numerous articles and books being published on these topics. Both teaching and learning differ in these two different environments. The courses used for this research were all taught with the lecture based tutoring methodology. Lecture based tutoring is a fairly new active teaching method. Active learning [1-3] is an effective and popular teaching style. Some common active learning techniques include: student voting [4], pair and share [5] and problem based learning [6]. In lecture based tutoring, the teacher individually calls upon a student and then tutors the student to the correct answer for the whole class to hear. Additional information about lecture based tutoring and its student learning outcomes can be found in [7,8].

Moving courses to online poses challenges for both students and faculty [9-11]. The spring 2020 semester provided ample evidence of the problems that faculty and students had switching to this mode of teaching. Fortunately, there are a variety of online teaching techniques exist [12].

Some research has been done that compares online versus in person learning [13-18]. However, this research is limited with only a few results. In general, it is typically difficult to compare these two learning environments. A major reason is the difference in the material. Many times an online version of the class exists, but is taught by a different person than the in person section. Alternately, both courses may not be offered simultaneously with different assignments. Thus, the students may have different experiences even in the same course, which is not easily comparable.

Any course in this study was taught in the following fashion. In each class period, some students were always present. Thus, the instructor could ask the students questions for comprehension and provide additional details as necessary. This also allowed for every class period to use lecture based tutoring teaching technique.

Everything that was said or written on the equivalent of a white board was also recorded. While the online students were never asked a question, the instructor would start the class period with questions from "online land." However, the online students were able to watch an active learning class. This has been shown to improve student learning outcomes [8].

In the instructors belief, the quality of the in person and on-line instruction was extremely similar. In fact, numerous in person students stated, "I am so glad this course is recorded, I almost always watch your lecture a second or third time to figure the material out." These recordings provided additional learning opportunities for all students.

3. **Comparing Student Learning Between In Person and Online Students**

The first study focuses on the student learning outcomes from the junior level course. Eventually, two online students and three in person students dropped the course. Therefore, there were 46 people in the face to face section and 5 in the online section. The scores of the student's midterms are divided by section. Microsoft Excel performed all statistical tests. The course had two exams and both exams were identical for all online and in person students.

First, an f test was run to test if the variances are equal between these two distributions with α=.1. That is, the null hypothesis is that the two samples come from distributions with equal variances. The output from this test is given in Table 1.

	Variable 1	*Variable 2*
Mean	64.20652	53.4
Variance	146.7397	106.8
Observations	46	5
df	45	4
F	1.373968	
P(F<=f) one-tail	0.42235	
F Critical one-tail	3.798959	

Table 1: Output of an f test for the midterm in the junior level course

Because $p = 0.42 > \alpha = .1$, we fail to reject the null hypothesis. Furthermore, with such a high p value to the f test and given that the students took the same exam and should have watched the lectures, it is assumed that the variances can be considered equal. Thus, a comparison of means test with the assumption that the variances are equal is performed. This t test has the null hypothesis that the means are equal and an alternative hypotheses that the means are not equal. The value of α=.05. The output from this test is given in figure 2.

	Variable 1	Variable 2
Mean	64.20652	53.4
Variance	146.7397	106.8
Observations	46	5
Pooled Variance	143.4793	
Hypothesized Mean Difference	0	
df	49	
t Stat	1.915888	
P(T<=t) two-tail	0.061223	
t Critical two-tail	2.009575	

Table 2: Output of a t test for the midterm in the junior level course

Because $p = 0.06 > \alpha = .05$, we fail to reject the null hypothesis at the 95% significant level. The p value is .061, so a higher α value of .1 would have resulted in a rejection of the null hypothesis. Even if it is not statistically significant, the online students appear to be doing substantially worse. As the semester progressed, the online students appeared to become even less engaged. The next study examines the final exam scores.

A similar strategy is followed for the final exam for this junior level course. Tables 3a and 3b have the f test and the appropriate t test. It should be noted, that the f has a p value of .035, which is low, and one would reject that the two variances are equal with 95% confidence. As a result, the comparison of means test was performed assuming unequal variance. This t test has a p value of about .02. Since α=.05 is a standard assumption, we can statistically reject with 95% confidence that the mean of the final exams between the in person and the online students are the same. It is evident that in person students had statistically better learning outcomes than their online piers.

	Variable 1	Variable 2
Mean	74.65217	66.3
Variance	192.3763	27.45
Observations	46	5
df	45	4
F	7.008245	
P(F<=f) one-tail	0.034699	
F Critical one-tail	3.798959	

	Variable 1	Variable 2
Mean	74.65217	66.3
Variance	192.3763	27.45
Observations	46	5
Hypothesized Mean Difference	0	
df	12	
t Stat	2.685587	
P(T<=t) two-tail	0.019831	
t Critical two-tail	2.178813	

Table 3a and 3b: Output of both an f and t test for the final in the junior level course

Clearly, the learning outcomes are worse for online students in this junior level course. However, the author does not believe that this always the case. He is the director for an in person and online masters of operations research degree. The online students in this masters program regularly exceed the in person students in learning outcomes. The classes for the masters program are taught in an identical method as the previously described junior level course. That is, the online students watched the lecture given to the in person students.

The next statistical analysis compares learning outcomes between the in person and online students in a graduate level Network Flows course from 2018. This course is a core class, and there were 13 in person and 9 online students. Again an f test is run first. The results are given in Table 4.

	Variable 1	*Variable 2*
Mean	88.73077	83.22222
Variance	119.1923	72.75694
Observations	13	9
df	12	8
F	1.638226	
P(F<=f) one-tail	0.246126	
F Critical one-tail	3.283939	

Table 4: A comparison of variances for the graduate level course

With an alpha value of .1, we fail to reject the null hypothesis because the p value is about .25. Furthermore, a statistical test comparing means is more likely to be rejected with equal variances, so a comparison of means test was run assuming equal variances. The results are given in Table 5.

	Variable 1	*Variable 2*
Mean	88.73077	83.22222
Variance	119.1923	72.75694
Observations	13	9
Pooled Variance	100.6182	
Hypothesized Mean Difference	0	
df	20	
t Stat	1.266428	
P(T<=t) two-tail	0.219912	
t Critical two-tail	2.085963	

Table 5: A comparison of means for the graduate level course

With α=.1, we fail to reject the null hypothesis, which is that the means of the scores are the same. Furthermore, the p value is .21. Even though the in person students have about 5% higher of an average on the final, there is no statistical evidence that their scores are truly different. The two highest scores belonged to two Ph.D. students that were almost graduating. In fact, if these two scores were eliminated from the in person students scores, then the average would have been 85.7. Consequently, one may conclude that the learning outcomes are similar between the in person and online students for this class.

These two courses and data show dramatically different learning outcomes. The answer becomes fairly obvious if one considers that the university tracks the amount of time that each student “spends” on the class in the on-line environment. These numbers are not exact. If a person does not logoff, then the university thinks that the person was working on the class longer than they did. This system also does not account for work done while not logged in. Thus, these numbers are at best suspect of the effort put forward by a student. However, these numbers do align with the author’s general experiences. The students in the junior level online spent about 40 hours logged into the online system. This time was not evenly divided and the highest was over 100 hours and the lowest was about 10 hours. In contrast, the online students in the graduate course spent on average 121 hours according to the university’s online tracking system. The highest was over 400 hours and the lowest was about 35 hours. Clearly, the students in the graduate level course spent more time logged into the system.

It should also be noted the students in the online junior level class were most likely taking their first full on-line class. These students had some online experience from the last half of the spring 2020 semester. However, these students were moderately forced into online learning through the fear of contracting Covid-19. The students in the graduate level course had willing enrolled in an online masters program and most likely completed several online courses.

The author’s primary conclusion is that the student learning outcomes between in person and online students are based upon the student and his or her effort. The students in the graduate level course had willingly enrolled in the online course and were pursuing an online masters degree. Furthermore, most of those students had completed a few online courses. Thus, they had desire and practice at online learning. These students spent on average about 3 times more time on this course as the students in the undergraduate course.

As instructors, the goal should be strong learning outcomes for all students regardless of the mode of delivery. The student learning outcomes between in person and online can be similar or dramatically different. The results appear to be based primarily on the student’s effort. Thus, instructors should emphasize to any online students about the difficulties of online education, and the need for the students to consistently work on the course.

4. Conclusion and Future Research

This paper examines the student learning in two courses. Both classes are taught in a hybrid teaching format. The in person students hear and participate in the lecture. This lecture is recorded and uploaded for the online students. Thus, all students have similar exposure to the material. In a junior level course, the online student learning was statistically significant and worse than the learning outcomes for the in person students. However, in the graduate level course, the student learning was similar between the in person and online students. Most interesting is that the junior level online students spent on average 40 hours on the class, but the master’s students spent 120 hours on the course on average according to the universities online tracker of time spent logged in. Consequently, the author concludes that the student learning outcomes for online students can be similar to the in person learning, but the online students must be diligent in their effort to complete the course. These results provide additional evidence that can be a substantial difference between online and in person student learning outcomes.

There remains a substantial amount of additional research. Only two classes were analyzed and additional courses may provide additional insight. Both of these classes used active learning techniques for the lectures, and a similar study on just a lecture type course may provide insight into that type of class. Probably the most important future research topic is how to improve student learning outcomes across all modes of teaching.

5. References

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Biographical Information

Todd Easton received a B.S. in Mathematics with a minor in Statistics from Brigham Young University (1993), an M.S. in Operations Research from Stanford University (1994), and a Ph.D. in Industrial Engineering from Georgia Institute of Technology (1999). He worked as a post-doctoral fellow and the Head Athletic Mathematical Coordinator at Georgia Institute of Technology (1999-2001). From 2001-2021, Dr. Easton was an Associate Professor in the Industrial and Manufacturing Systems Engineering Department at Kansas State University. In 2021, he took a lecturer position in the Mechanical Engineering Department at the University of Utah.

His research interests are in combinatorial optimization with an emphasis in integer programming and graph theory. He has been the major adviser to 3 Ph.D. and 36 master theses. He developed a new active learning teaching style called lecture based tutoring. He has successfully implemented this technique in both undergraduate and graduate classes, which has

spanned 20 distinct courses. He has received numerous teaching awards and Kansas State University awarded him the title of University Distinguished Teaching Scholar in 2017.