

Comparing two versions of an engineering course: in-class and on-line. What does the data say?

Tariq Khraishi

Professor

Mechanical Engineering Department

University of New Mexico

Albuquerque, NM 87131

khraishi@unm.edu

Abstract

This paper presents data from the same course taught differently: on-line and traditionally in a classroom. The course in question is an engineering course at the sophomore level and is entitled "Energy, Environment and Society". The paper contrasts differences in grades, or in student response/behavior, towards these two versions of the course. It also points out the wealth of data obtained using the on-line method including some interesting observations. A main result of the study is that the grades for group work activities seemed to be lower for the online mode of teaching, and that individualized exam grades (midterm and final) seemed to be similar for the two modes.

Introduction

In the last few years, online courses or classes have been more and more present and advertized/offered by different academic institutions. The typical in-person or in-class courses are shrinking in offerings at some institutes. More and more institutions are offering courses, even whole degrees, on-line. A lot of them offer graduate courses and programs online. Some, even at the high-school level, are offering online degrees.

LaMeres and Plumb (2014) found out that converting undergraduate digital circuits to online delivery is as effective as in-classroom offerings. They even found the same result for an undergraduate digital systems laboratory using a remote lab approach. Reid (2006) in the Electrical and Computer Engineering Technology Department at IUPUI studied the conversion of two courses (Digital Fundamentals and C++ programming) has gradually changed two courses from a traditional lecture / laboratory format to an online format. They found that student success was comparable to success in a traditional format using a self-assessment and final exam scores. But they found serious issues with student retention and with student satisfaction with the online format of course offering. Pisupati and Mathews (2008) found out that "the average quiz scores for online and face-to-face sections were identical". They also found out similar average scores for the midterm and final exams. However, they found out that the students perceived the online portion/format to be more difficult and challenging. Douglas (2015) found out for an engineering statics course that "there was little to no difference in content mastery between students who completed the online and face-to-face sections of the class". This includes score on identical proctored exam problems. However, they also found that the withdrawal and non-completion rates were higher in the online classes than the face-to-face classes.

In this paper, we present data from two versions of the same course (a traditional in-room/in-person version and an on-line version). Specifically, we show how students fared in both versions in terms grades in the different components of the course. Also presented are interesting stats and numbers on student behavior in the online course; stats/numbers that are more readily available using an online teaching methodology.

Background

The class name as mentioned in the **Abstract** is "Energy, Environment and Society". It is a sophomore level course taught by the Mechanical Engineering Department at the University of New Mexico (UNM). Its number in the UNM catalogue is ME217. The course covers a history of energy, its definition, use and exploration by humans over old and modern history, different types of energy sources, basic physics and chemistry pertaining to different energy sources (fossil fuels, nuclear energy, and renewable energies). It also discusses environmental impact of different energies, the economics of them as well as conservation efforts associated with energy use. Since its introduction in the ME curriculum, it's been a popular course as it gives the students early-on a more comprehensive, or big-picture, view which is lacking from most engineering courses. It also provides them with a basis for the importance of energy (as concept and application) in the rest of their curriculum. The course also satisfies several ABET A-K outcomes.

The first author of this paper has taught this course every year since 2010, and in the summer every time. Another teacher teaches it during the regular academic year and usually in the fall semester. The material covers most of the chapters in the chosen textbook (see Table 1) and for the online classes, the lectures were recorded with video and audio (using PowerPoint presentations).

The author has followed a typical grading scheme for letter grades, where As (A and A-) range from 90-100 total accumulation or total percentage scoring in the course, the Bs (B+, B and B-) range in the 80-90, etc. Also, the course components (assignments, quizzes, group presentation, and two exams) have the weights provided in Table 1. Quizzes were introduced in 2013, the first year of offering the course online. The quizzes are short tests which range from 4 – 8 questions and last for 10 minutes max. Every week there was a pre-quiz and a post-quiz. The pre-quiz was to be taken after reading the chapter of the week. The post-quiz was to be taken after also seeing and listening to the online lectures on the chapter of the week. The quiz material was out of the chapter and the online lectures cover the textbook chapters while providing supplementary material. All tests (quizzes and exams) are taken by individual students, whereas the assignments and presentation are done in a group. One grade or score per group is given for all group members.

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Course Grading (component weights):			
	2010	2011, 2012	2013, 2014, 2015, 2016
Assignments/Homeworks:	15%	20%	15%
Quizzes:			5%
Group Presentation:	5%	5%	5%
Exam 1:	30%	30%	30%
Exam 2 (final):	40%	45%	45%
Project*:	10%		
* not given in 2010			
2010-2013 textbook: book by Joseph Priest, 6th edition, Kendall Hunt Publishing Co.			
2014-2016 textbook: book by Joseph Priest & Mario Freamat, 6th edition, Kendall Hunt Publishing Co.			

Table 1. Weights for different course components for ME217 over the years.

In the next section, scores on the different course components in the in-person classes and in the on-line classes are presented. Also, presented are the number of students in each class and the number of groups participating in assignments and group presentation. The percentage of students earning As (including A-) is contrasted across the years. Also, aspects of the online offerings are discussed.

Results and Discussion

First off we present grades/scores from the different years (in-person offerings and online offerings) for the different course components. Table 2 shows all the years the course was offered (2010-2012: in-person, and 2013-2016 online). The second column shows the number of students enrolled in each of these classes (tallied after the initial registration period instability, i.e. not the very initial roster but rather the class finishers). Column 3 in Table 2 shows that every class was divided, at the beginning of the class, into 6 groups for assignments/homework purposes and for the purposes of the group presentation.

Column 4 in Table 2 shows the number of student split into groups at the beginning of the semester. This number (i.e. number of students per group) has a range and is not one uniform number. Notice that, overall, there were initially more enrollment in the online classes and hence their group number (or group size) was bigger overall than the in-person classes. The group sizes presented in Column 4 deviate (about half of the classes) from the ideal group size/group number presented in (Khraishi 2011) which is *e*.

Column 5 shows the range for the average of group GPAs for each of the classes. You will notice here that all groups within a class were very close in terms of their GPA. Indeed, the average group GPA in each of the classes is provided in Column 6 and lies closely in between the range limits in Column 5. Note how the group GPAs, across groups in a specific year, are almost the same (with the exception of 2014 which is discussed below). Here, the groups were

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divided based on a method that produces similar average GPA in each group. This method was first discussed by the author in (Khraishi and Kimsal, 2006; and in Kimsal and Khraishi, 2006) and used since in other ASEE GSW publications by the same author. To date, this method almost always produces groups with very similar GPAs. This indicates that overall student GPAs follows some sort of a normal distribution. The reason the 2014 year was off compared to other years in the tightness of the range is that the first group had a student with a considerably low GPA that it affected the average GPA calculation for that group.

In-classroom/In-person											
Year	# of students	# of groups	group # range	group GPA range	Group GPA Average	Average HW %	Average Group Presentation	Range Group Presentation	Exam 1 %	Exam 2 (final) %	Quizzes %
2010	17	6	3-3	2.92-3.11	3.01	82.09	93.95	90.38-95.54	87.06	87.15	
2011	18	6	3-3	3.00-3.19	3.07	92.88	97.30	95.83-99.04	92.22	84.03	
2012	26	6	4-5	3.06-3.18	3.14	96.58	97.03	94.89-99.40	92.82	84.81	
Total	61										
Average	20.33	6.00			3.07	90.52	96.09		90.70	85.33	
Online											
2013	33	6	6-7	3.14-3.20	3.16	81.15	94.81	91.91-95.83	91.67	84.54	80.80
2014	23	6	4-5	2.81-3.56	3.39	91.43	94.05	92.19-96.43	91.67	86.94	73.43
2015	18	6	3-4	3.07-3.35	3.27	89.97	95.74	93.18-97.50	87.04	83.08	77.93
2016	20	6	4-5	3.35-3.46	3.40	83.21	92.12	88.46-94.79	88.00	81.78	76.52
Total	94										
Average	23.50	6.00			3.31	86.44	94.18		89.60	84.09	

Table 2. This table shows the years, number of students, number of groups, range of group numbers, average group GPA, and average percentage score in the different course components.

Starting with Column 7, the performance of students in the different course components are presented and contrasted for the in-person classes and the online classes. Starting with Column 7, it can be observed that the online students, on average, did not score as well on homework assignments as did the in-person students. This could be attributed to the fact that the online groups may have a harder time getting together or coordinating/collaborating as a team given the fact that they can only get together in virtual space and not physically in a real place. Moreover, such groups do not see each other regularly in the classroom to interact like the in-person classes. That face-to-face interaction in the in-person classes facilitates homework/assignment discussions for a group.

The same comments about group interaction in online classes versus in-person classes can be made regarding Column 8 which lists the average score on the group presentation. It is noticed here that the in-person classes score in general above the online classes for the same 6 presentation topics by the six groups in each class. This could be attributed to the same reasons as above, i.e. limited in-person interaction between the groups compared to the classroom setting. This limited interaction transcends to not just student-student interaction but also to student-faculty interaction as in the classroom the professor can follow up more closely about the group presentations and answer any questions the groups may have. It is important to point out here that both online and in-person classes got the same six presentation topics as well as the

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same written guidance/recommendations on best presentation practices and other presentation details.

Following in Column 9, the range of group presentation scores show that most groups score closely to other groups. This is an affirmation in a sense of the group divide method mentioned above as in this method some groups have a bid disparity in individual students GPAs and some groups have more similar GPAs amongst the group members. It does not appear that this method has been responsible for bad group dynamics/groupings.

Going on to Column 10 and Column 11, they show the average scores per year on the two exams administered in ME217. The first exam is a midterm and the second exam serves as the final exam in the class. The first exam is exactly the same between the online and in-person classes, i.e. same number/wording of multiple-choice questions. However, the second exam is a little different between the online version and the in-person version. Here the online version has four more multiple-choice questions than the in-person version (or 10% more). The rest of the questions are the same though. Independent, we are comparing here the percentage scores and therefore the two scores (online and in-person) should be able to be compared head-to-head. It is to be noted here that even in the in-person classes, both exams were given on the Internet just like the online classes. Looking at exams 1 & 2, it appears that there is really no difference in the scoring when comparing online to in-person classes. This a relief of sort in the sense to know that moving the class from an in-person or in-classroom setting to a purely online setting would not have a negative impact on student test scores.

The last column in Table 2, Column 12, shows the scores for the quiz component in the course. The quizzes were only done with the only classes in the form of a pre-quiz and a post-quiz every week as explained above. The quizzes were only done in the online classes. It is seen here that the average scoring on the quizzes is lower than the average scoring on any other course component. The quizzes, being de-emphasized in terms of their total weight (i.e. just 5% of the course), require discipline from the online students as they are timed assessments (in terms of both date and time of day/night) and require weekly reading and listening to lectures online. They are also individualized tests so it is up to the student to be on top of their game so to speak and be up to task on these repetitive short assessments. It is predicted here that the lack of this discipline, at least with some students, have contributed to a lower average percentage score on the quizzes compared to any other course component. More discussion on quiz data will be provided later in Table 4.

The last direct comparison between scores in the online classes and the in-person classes is for the percentage of students getting A and A- (i.e. 90-100%) across the years. Table 3 shows such data. It is clearly observed in the table that a lesser percentage of online students obtained A (or A-) compared to the in-classroom students. It is believed that the reason for this is tied with the data in Table 2. In Table 2, it was shown that on average the online students score less on group work (homeworks and presentation) than the in-classroom students. So that is one difference in the final class score/letter grade. Another difference is due to the last column in Table 2, i.e. the quizzes. There were no quizzes in-person but there were quizzes in the online classes. Moreover, it was commented in the last paragraph that the students did less on quizzes than any other online

class component. These two differences combine, in our opinion, to a lower overall score for the online students in comparison to the in-classroom students, and thus the explanation for lowered A or A- attainment.

In-classroom/In-person	
Year	% A and A-
2010	47.06
2011	61.11
2012	65.38
Average	57.85
Online	
2013	36.36
2014	52.22
2015	22.22
2016	30.00
Average	35.20

Table 3. Comparing the percentage of students receiving an A or A- in both the online classes and the in-person classes.

Now that we have covered in discussion the different course components and how the students fared online or in-classroom, we move on to other data facilitated in the online classes. First off consider Table 4 which shows data for the 20 students in the 2016 class. Similar data for other online offering years exist but not shown here for brevity. This table shows all 20 students in the class and their score in the weekly pre- and post-quizzes. Although explained above that the pre- and post-quizzes (which are separated by two days every week to allow for lecture viewing/listening after the chapter reading) are exactly the same (with the exception of the order of question presentation), we notice that there are:

- 1- students who took the pre-quiz and missed the post-quiz (despite having two days to do the post-quiz after the pre-quiz)
- 2- students who took post-quiz but not the pre-quiz
- 3- students who did both #1 and #2 above! i.e. they were in-consistent in this regard
- 4- students, who in a week, skipped taking both the pre- and post-quizzes.
- 5- students, who in a week, did worst in the post-quiz than the pre-quiz! This does not make sense as the scores of most students show since there is an expected progression or at least stagnation between taking the pre-quiz and the post-quiz. It appears that such students were careless in taking such tests.

One last note about this table is that the above-discussed misses and carelessness in quizzes, contributed overall to the lowest percentage of scoring in any of the online class components as was shown above in Table 2 (in Column 12 specifically).

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Student #	Pre-quiz 1	Post-quiz 1	Pre-quiz 2	Post-quiz 2	Pre-quiz 3	Post-quiz 3	Pre-quiz 4	Post-quiz 4	Pre-quiz 5	Post-quiz 5	Pre-quiz 6	Post-quiz 6	Pre-quiz 7	Post-quiz 7	Pre-quiz 8	Post-quiz 8
	5	5	8	8	6	6	6	6	4	4	6	6	6	6	6	6
1		4	3			3	4	6	4	4	4				4	5
2	4	5	6	7	3	5	5	5	2	4	4	6	6	6	2	3
3	4	4	6	6	5	6	6		4	3		6	6	6	5	6
4	3	3	4	7	6	6	6	6	4	4	6	6	4.5	6	4	6
5	3	4	3		3	4	6	6	3	3	6	6	6	6	5	5
6	3	4	6	8	6	6	6	6	4	4	6	6	6	6	5	6
7	3	4	6	8	6	6	6	6	4	4	6	6	6	6	5	6
8		3		8		5		5	3	3	6		6	6	4	6
9	3	2	5	4	5	6	4	6	2	3	6	6	5	6	5	6
10		4	6	8			6	6	3	3	6	6		4.5		4
11	4	4	7	8	6	6	5	6	3	4	5	5	4.5	6	4	6
12	3	4	6	8	6	6	6	6	3	4	5	6	6	6	5	5
13	4	5	2	5	4	6	5	6	4	2	5	4	6	6	2	5
14	3	4		7	6	6		6			5	6	6	6	4	5
15	3	5	6	8	3	6	6			4	6		6	6	6	6
16	4	3		6	5	6	6	6		3	5	6	6	6	4	6
17	3	5	8		6	6	6	6	4	4	6	6		5.5		5
18	3	5	6	8	5	6	6	6	3	4	6	6	6	6	4	5
19	4	5	8	8	4	5	6	6	2	4		6	5.5	6	5	5
20	2		3			5	5	6	2	4	6	6	6	6	2	5

Table 4. Pre- and Post-quiz data from the 2016 online class for 20 students. The second line or row shows the maximum possible score where the first column shows student scores for 20 students.

Other interesting data that can be gleaned online only are things like the number of online accesses for a specific element of the course. For example, Figure 1 shows the access pattern on a daily basis for the last lecture of the online course in 2016. Figure 2 shows the access pattern for the same course element but for the “day of week” data. Some of this data makes sense. For example, Figure 1 shows that the hours of most access are early in the day, around lunch and around 5pm. Figure 2 shows most access during the weekday and not on weekends. Also, the access gradually builds up due to how the weekly module is constructed where weekly activities start on Monday and build up through Friday and sometimes through Saturday.

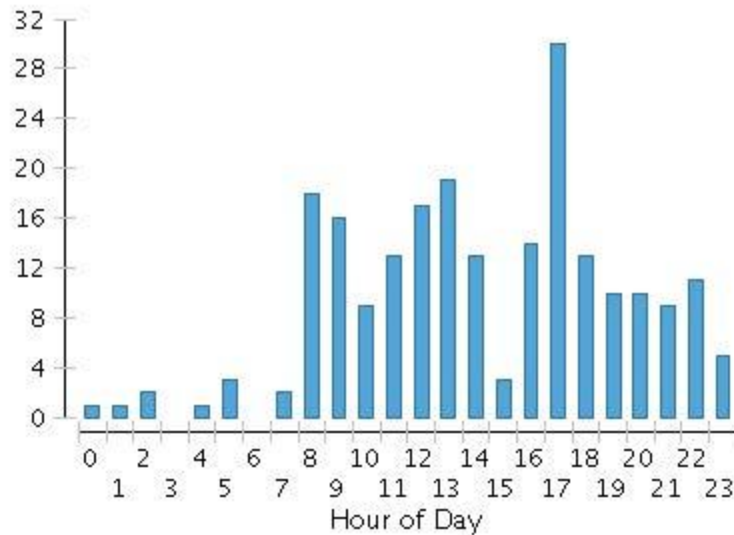


Figure 1. A frequency histogram of the hour of the day (x-axis) during which online students accessed Lecture 14 in the Week 8 module in summer 2016.

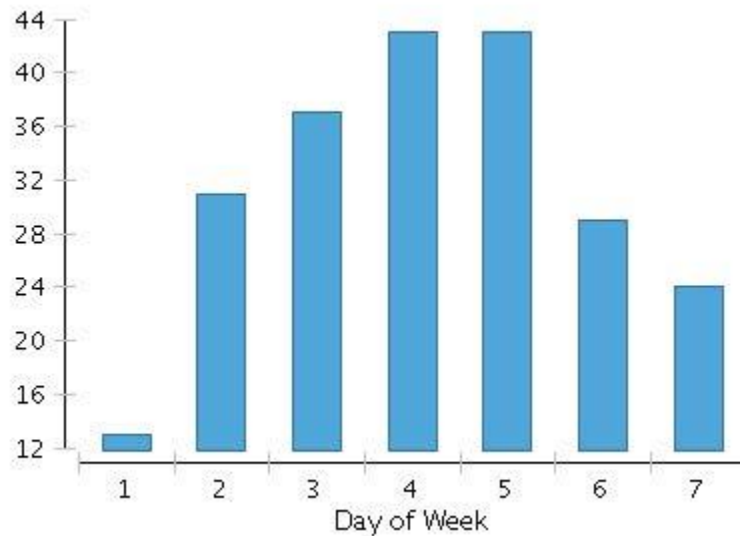


Figure 2. A histogram of the day of the week during which online students accessed Lecture 14 in the Week 8 module in summer 2016.

Conclusions

From the above data and discussion, it appears that the online classes result in general in lowered grade letter and course component attainment. Overall though, it appears the transition to an online course had no bearing on the two main components of the course (the midterm and final exams). The components that got affected were those involving group work, specifically homeworks and group presentation. It appears that the lack of in-person meeting for group

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members affected the communication and grouping needed to better accomplish the group tasks. The inclusion of quizzes in the online classes also contributed to lowered overall class scores due to the discipline required to be successful in these quizzes.

There were other data extracted from the online offerings. One of them is with regard to daily and hourly access during the week. Another is with regard to quiz taking. Such data provides certain insight on student behavior and tendencies that otherwise may not be available.

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