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ENHANCING LEARNING EXPERIENCE IN ONLINE COURSES THROUGH ENRICHED RESPONSIVENESS

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Abstract

This paper evaluates three enhancements to student interaction and collaboration: 1) a set of recorded lectures available in indexed segments of 5-10 minutes, 2) mentored assignments, and 3) pre-recorded small group project presentations, comparing their relative efficacy for online courses with on-site courses. The recorded lecture segments have proved to be effective for online student learning and for onsite students to review and master concepts they had difficulty grasping when presented initially. The mentored assignment process enables online students to have effective interactions with other online students, by focusing their attention on a few others rather than the whole class. Data is presented showing that quality of research, original thinking, understanding of subject, and thoroughness of work is at least as good for online students as for onsite students. Similar results are presented showing the effectiveness of small groups working together to develop a recorded group project presentation. The process of developing the recorded presentation enables effective collaboration and frees students from obstacles that have been encountered in trying to use small group projects effectively in online courses. Data is presented showing that small group project quality is comparable for online and on-site courses when this approach is used.

Keywords: Effective teaching, higher education, mentoring, online learning, student interaction.

Introduction

A number of findings support the fact that many university students find online courses to be a good choice (Study 2008). The Online Learning Consortium says that at least 6.7 million students have taken a minimum of one course online. This is nearly one third of all students enrolled in higher education. (Online Learning Consortium, 2012). A variety of reasons drive this choice, and those reasons have been explored in a number of studies (Gillingham and Molinari, 2012; Glover and Lewis, 2013; Mann and Honeyberry, 2014; and Jaggars, 2014). This paper does not discuss the reasons students choose online courses. This paper presents some results of the research to improve the effectiveness of one challenging graduate cyber security course that is required in MS in Computer Science and MS in Electrical Engineering programs in this institution. The course is offered in both online and on-site modality.

There may never be complete agreement on whether online courses provide a learning experience that is as good as on site course; however findings in the last decade are encouraging for supporters of online learning. For example, Allen and Seaman report that 77 percent of academic leaders "rated the learning outcomes in online education as same or superior to those in face-to-face." (Allen and Seaman, 2013). Based on research findings, the authors maintain that

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there has been considerable improvement in the effectiveness of online courses, and they can be just as effective as on-site courses. The authors have found that it is possible for the online version of a course to be more effective than the same course taught on-site. Course design along with the approach taken by the instructor is two important determinants of effectiveness. In a study conducted in the last decade, Uhlig, Viswanathan, Watson and Evans found no statistically significant difference in learning when they compared 600 students in 28 engineering courses taught both online and on-site (Uhlig et al, 2007). Their work describes some of the best practices that produced this result. This paper reports on findings when several innovations were added to a graduate Cyber security course. Results were obtained from six offerings of this course in the Master of Science in Computer Science program. There were 39 students in the on-site control course in February 2015, before the innovations were incorporated. 17 students took the course onsite in July 2017. 20 students took the same course online in December 2016, and 27 students took the identical course online in December 2017. 11 students took the course onsite in July 2018 and 21 students took the same course online in December 2018.

Enriching Responsiveness in Online Courses

There are a number of important characteristics of effective teaching. Smyth (2011) found that the same characteristics were valued by both online students and on-site students, but those characteristics were ranked differently. Nine important characteristics of effective teaching were ranked in order of importance as follows for face-to-face teaching:

1. Respectful
2. Knowledgeable
3. Approachable
4. Engaging
5. Communicative
6. Organized
7. Responsive
8. Professional
9. Humorous

When the same characteristics were ranked for effectiveness in online teaching, two of the characteristics moved significantly. “Responsiveness” moved up from seventh place in face-to-face teaching to second place in online teaching, while “Engaging” moved down from 4th place to 7th place. The other characteristics remained in the same order, with “Respectful” maintaining first place. The significant move up the rankings of “Responsiveness” for online courses is consistent with expectations of the digital age, where instant responses are expected and demanded. But, this has a major impact on the way an online course should be conducted.

The downward movement of “Engaging” from fourth for on-site courses to seventh for online courses may imply that online students simply have less contact with their instructors and, therefore, are less concerned about how engaging the instructors are. All of the three

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characteristics at the end of the list for online teaching are more difficult to observe and to convey in an online environment. The rank ordered list for online teaching is:

1. Respectful
2. Responsive
3. Knowledgeable
4. Approachable
5. Communicative
6. Organized
7. Engaging
8. Professional
9. Humorous

Based on numerous online courses the authors have taught, they can confirm that respect for students is of high importance. The authors strive to offer respect to all of their students in several ways. For example, they invite the students to post in a discussion board what they are expecting to learn in the course for the teacher's review. Students appreciate being asked, whether or not they respond, and the responses are useful for tailoring each course for those who do respond.

A more critical part of showing respect to students is setting appropriate expectations for grading assignments, exams and projects and making sure those expectations are met or exceeded. This corresponds directly to being responsive – the second characteristic on the list for online courses. Instructors who are lax in grading often receive lower student assessments of teaching. Another part of responsiveness involves providing answers to student questions. Those answers are typically given immediately in an on-site class. But answering questions in online courses necessarily involves a time delay. Some questions come in the form of email. Others are posted in discussion boards. Responding to student questions in an online course requires checking emails and discussion boards often. The most successful instructors often check the requests and provide the answers on-the-go using smart phones every couple of hours. Many students have expressed their surprise and appreciation for the rapid responses they receive.

Approaches to Enriching Responsiveness

Three new activities were added to the course. Student performance in six new instances of the course was compared with student performance in the same course before these features were added. The new approaches were: 1) Twenty-two hours of lectures broken down by major topics were developed. Access to these lecture materials was provided on a highly granular level. The full set of 22 hours of material contained the same content that was delivered in live lectures in the on-site classes; 2) Mentored writing assignments, and 3) Small group projects. Two other classmates in the same class mentored each student for the mentored writing assignments. Online students (and sometimes on-site students) were required to produce a polished recorded presentation of the results for their small group project. The impact of the implemented approaches is in the following sections.

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Granular Recorded Lectures

The authors started with more than 600 PowerPoint charts that had been developed for the on-site version of the course. One of the authors had used these charts many times to deliver the lectures. The same instructor added voice annotations to each of the PowerPoint charts, as if he were lecturing on-site. Adding voice-annotations is simple using the MS PowerPoint "Insert Audio" command. Captioning is added automatically to this material for the hearing-impaired before it is posted in the Learning Management System. It is worth pointing out that the voice annotations contain the same kinds of natural language as a live class, including pauses for the professor to think, and use of "uh" and "um". Raising the pitch of the voice to emphasize a point is not only appropriate but important. All of this provides the same "feel" for a student listening to the recording as the "feel" of a student in a live lecture. The recorded lectures do not need to be any more "perfect" than an on-site lecture. This helps prevent the recordings from sounding like "canned" lectures.

The authors strive to make each segment of recorded material approximately 5-10 minutes in length, and each segment has its own title. A sample of a few segment titles related to the topic of encryption includes: Basic Concepts of Encryption, Substitution Ciphers, Encryption Protocols and Key Length, The Data Encryption Standard (DES), The Advanced Encryption Standard (AES), and Public Key Cryptography. Online students can listen to the segments in small chunks or large chunks, as their schedules permit. Lecture segments are posted to the appropriate "weekly lectures" in the learning management system. Students can see the length of each segment before they start listening so they can decide whether they have enough time available to listen to the whole thing. They can listen on their Smartphone, their tablet, their laptop or even on a desktop computer. Many students have expressed their appreciation for the recorded lecture segments.

The segment titles even help on-site students, who now have the option to listen to part of a lecture again, even though they already heard it live in class. This option is not typically available in an on-site class and was an unanticipated benefit of the recorded lecture segments. Several students have reported that this is a useful form of review which enabled them to finally absorb a concept they had been having trouble grasping. This approach can be particularly helpful for students who prefer the verbal/linguistic learning style. (Uhlig and Viswanathan, 2006)

Impact of Mentored Assignments on Online Courses

Availability of instructor time for responding to students is always a concern. This concern can become acute with writing assignments. It is often the case that multiple students send a partially completed assignment to an instructor, asking for feedback about whether they are approaching the problem correctly. This can multiply the time required for providing guidance to students, and sometimes requires repeating the same guidance over and over to different students. Mentored assignment was developed to enable students to help each other in analyzing and evaluating the approaches being taken for an assignment by comparing their approach with

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several others. This does not completely eliminate confusion over an assignment, but it helps reduce it.

The mentored assignment evaluated in the cyber security course requires students to submit a 3 to 5 page written paper discussing a proposed design for an authentication system that learns by observing user behavior over time. To enable students to do this, they are first taught basic authentication concepts, including strong passwords vs. weak passwords for systems that authenticate users based on an <ID/password> pair, and multifactor authentication. Most of us have become familiar with multifactor authentication through online banking systems which send a code to a user's cell phone after the user logs in with <ID/password>, and requires the user to enter the code to ensure that the person providing the user <ID/password> pair is really the authorized user. In this assignment, students are encouraged to go beyond multifactor authentication to consider multiple kinds of user behavior that could be observed over time to make the authentication process stronger with time. This could include things like what location(s) the user tries to log in from, applications frequently used in a user's computer or smart phone, times of day when a user logs in, typing speed, writing style, and more.

Students start by writing a first draft, for their mentors' review and comment. Every student is assigned two classmates as mentors. As a result, every student receives feedback from two mentors, and every student provides feedback to two other classmates. As a result, they are able to compare their own approach with four others in the same class. Mentors are counseled to review and offer substantive feedback about content and approach to the classmates they are mentoring. Students are free to accept or reject the advice they receive from their mentors. In addition, they are free to incorporate in their own papers ideas they may learn from the students they are mentoring. In this way, every student interacts with four others in the same class. The instructor sometimes still receives questions about the assignment, but most students are satisfied with the feedback from their mentors. Additional details about the process have been provided by Uhlig, Sinha, Jawad, Dey and Amin (Uhlig et al, 2017).

The directions to mentors are that they provide comments that can be used by the classmate they are mentoring to improve the content of their paper. Mentors are specifically requested not to comment on grammar; that is the responsibility of the instructor. Comments made as mentors are part of each student's grade for the assignment. Comments like, "I like your paper" are okay but are not considered useful comments for the purpose of improving the paper of the person they are mentoring. Despite these instructions, some problems have been experienced with the quality of feedback. Some mentors take their responsibility seriously and provide useful, actionable feedback. Others do not. One example of high-quality feedback given by one mentor is:

> "I can see the different metrics, but it would help me understand the progression of the system if I knew what it did with this information. For instance if you, bring your laptop to a coffee shop every day at 5:00pm, can the system ask 'what do you like to do at your current location?' once it sees the IP of the coffee shop. Or if you didn't go to the coffee shop at that time, would you be prompted with a

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> security question? Also, would the user be allowed to choose what progression pathway to use? Or would they use all of the suggested options (i.e. device, time of day, session length, and biometrics)?"

A problem was experienced with procrastinators. There are usually a few students who wait until the last day to send first drafts to their mentors. Mentors are advised that they do not have to provide comments on a draft that is received very late, and that it will not count against the mentor's grade when this happens.

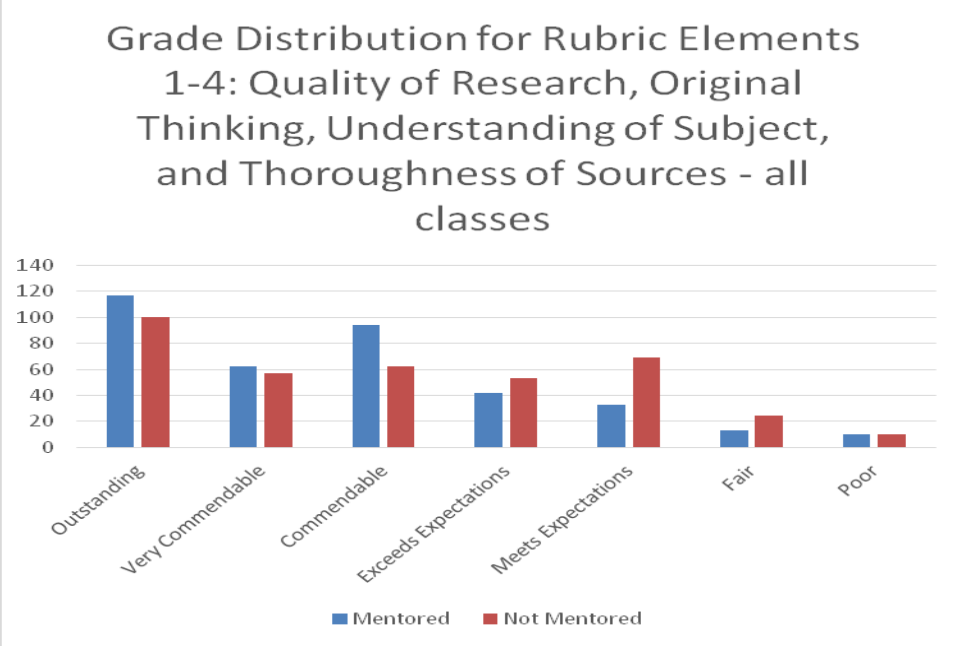

Figure 1 – Grade element distribution for Mentored vs. Non-Mentored Assignments

The mentoring process has proved to be a success. Some excellent ideas have emerged for enhancing the authentication and authorization process through a system that learns by observing user behavior over time. Suggestions made by students to each other in the mentoring process, including review of what classmates are proposing, has resulted in greater depth and some ingenious solutions. A comparison of four elements of the grading rubric indicates that meaningful learning has resulted from the process. These elements include quality of research completed, demonstration of original thinking, demonstration of understanding of the subject, and thoroughness of references. Each of these four categories is assessed as: outstanding, very commendable, and commendable, exceeds expectations, meets expectations, fair, or poor. The rubric, given to each student, provides details of what constitutes each level. Data for two writing assignments has been analyzed for each of the five different instances of the course taught in December 2016, July 2017, and December 2017, July 2018 and December 2018. The three December classes were taught online. The two July classes were taught onsite. The first assignment in each class was mentored. The second assignment was not mentored. Figure 1

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shows the distribution of these grading elements across the five classes for the mentored assignment versus the assignment that was not mentored. The mentoring process has moved a significant number of students into the Outstanding, Very Commendable and Commendable categories from the "Exceeds Expectations", "Meets Expectations" and "Fair" categories.

The number of students in each of the top three categories increased. The students in the top three categories help the students in the next three categories. The students who need help the most, receive the most meaningful comments and suggestions for improvement from the better students.

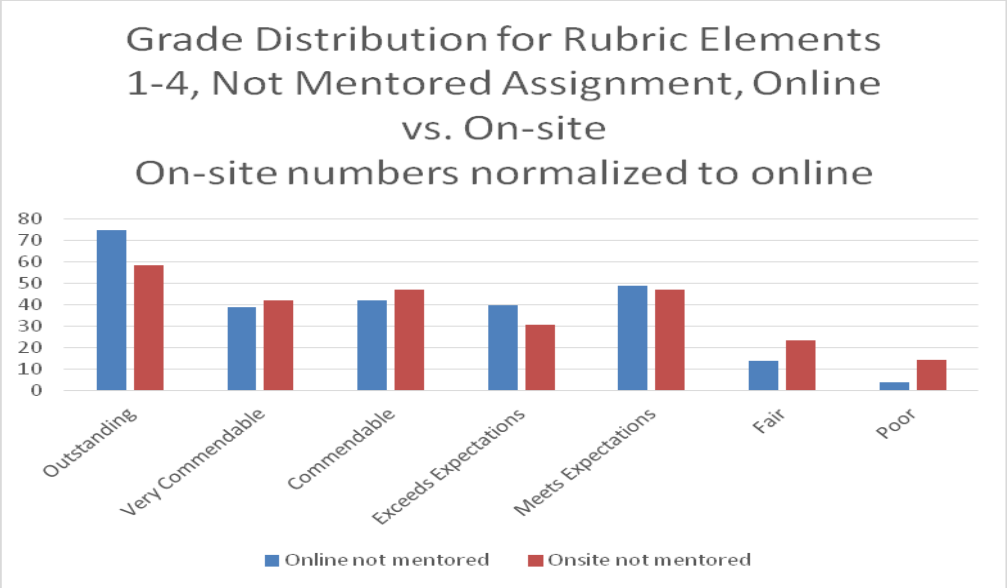

Figure 2 - Grading Distribution for Not Mentored Assignment – Online vs. On-Site

To better understand potential impact of the mentoring process for both the online versions of the course and the onsite course, the authors first compared the distribution of these same grading elements for the non-mentored assignment between the online and on-site versions of the course. Figure 2 shows the two distributions for the non-mentored assignment. The distribution for online courses contains actual numbers. To make it easier to compare the two distributions, the onsite distribution has been normalized to the total number of students in the three online courses. There does not appear to be any significant difference in the shape of the distribution for the on-site class and the distribution for the online classes, as was expected.

Figure 3 compares the distributions for the mentored assignment between the online and on-site versions of the course. There is a shift to better learning and better grades for the online courses. This demonstrates the effectiveness of the mentoring process. It is not surprising that the impact is greater for the online courses where there are fewer opportunities for students to interact with one another.

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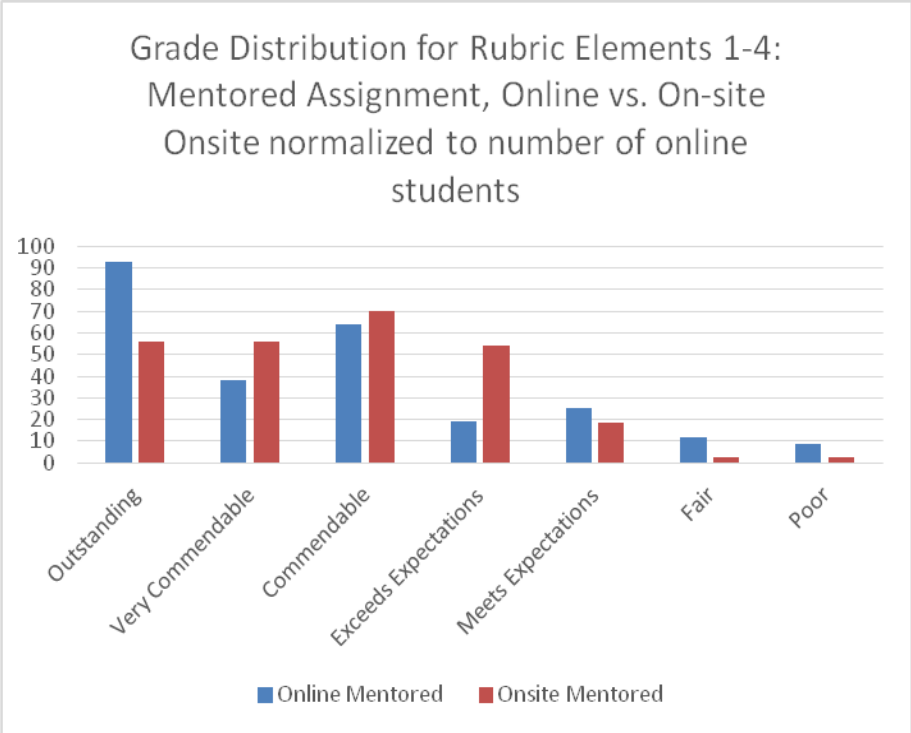

Figure 3 - Grading Distribution for Mentored Assignment – Online vs. On-Site

Impact of Small Group Projects in Online Courses

In online courses in the past the only way to have a small group present their results was to have all members of the group participate in real time. But this tended to defeat an important purpose of online courses, to enable participants to learn in whatever time is convenient for each individual. It often posed a hardship for individuals who had to work. The authors addressed this issue directly by having the small groups produce a recorded presentation of their findings. Each member of the small group can work asynchronously on their individual part of the presentation. Details of the process have been discussed by Uhlig et al (Uhlig et al, 2017). This modified process provided unanticipated dividends. The resulting small group presentations were found to be better than the "live" presentations in synchronous online sessions. Group members produce higher quality presentations as a result of reviewing each other's work and helping each other as the recorded presentation is developed.

Members of the class outside each small group are required to listen to the full recorded presentation by at least one other group and to provide meaningful comments, including whether or not they agree with the other group's findings and their approach. This resulted in meaningful online discussions and good interaction among members of the class.

Uhlig et al (op. cit.) presented preliminary distributions of the four grading elements: Quality of research, Original Thinking, Understanding of the Subject, and Thoroughness of References for

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small group projects. Figure 4 shows these distributions extended to the combined three online courses in December 2016, 2017 and 2018 versus the combined distribution for the July 2017 and 2018 online courses. There were a total of 272 grades in the online courses and 236 grades for the on-site courses. The on-site grade distribution in Figure 4 has been normalized to the online distribution. The distributions are remarkably similar, demonstrating that learning in the online courses is as good as in the on-site courses, insofar as the small group projects are concerned.

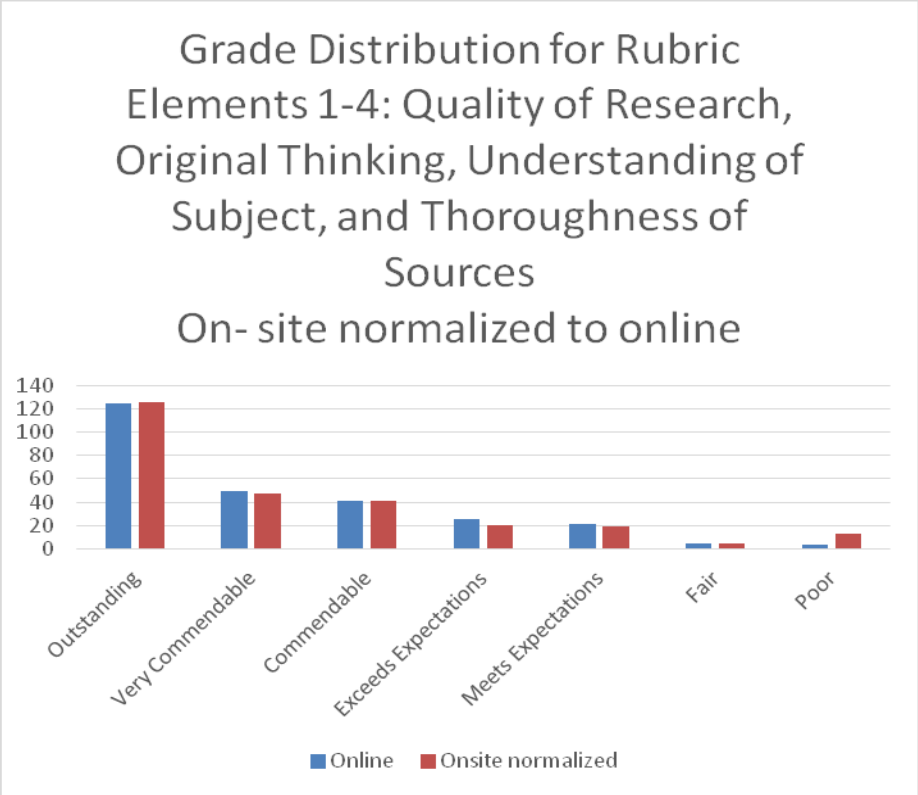

Figure 4 Grading Distributions for Small Group Projects – Online vs. On-Site

In a previous paper the authors compared overall grades for small group projects in an online class with grades for small group projects in an onsite class for courses through December 2017 (Uhlig et al, 2018). Figure 5 shows these data extended to six classes. February 2015, July 2017 and July 2018 were onsite classes. December 2016, December 2017, and December 2018 were online classes of the same cyber security course. Small group project presentations were "live" in the February 2015 and July 2017 courses. Small group presentations were recorded in the December 2016, 2017, and 2018 courses.

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	Dec-17				Jul-17				Dec-16				Feb-15			
	Online				On-Site				Online				On-Site			
	Avg	Std Dev	Max	Min	Avg	Std Dev	Max	Min	Avg	Std Dev	Max	Min	Avg	Std Dev	Max	Min
Project Set 1	91.81%	6.20%	98.90%	80.60%	90.96%	4.60%	96.60%	85%	95.37%	2.33%	98.20%	90.20%	90.91%	2.35%	95.60%	88.40%
Project Set 2	Project Sets 1 and 2 were combined in this class				93.12%	2.09%	96.40%	89.80%	95.60%	4%	100%	88.40%	90.60%	3.32%	96%	86.13%
Cracking WiFi Project	93.48%	5.11%	99.60%	83.30%	94.94%	3.73%	99.53%	89%	96.44%	2.85%	100%	91.20%	94.43%	1.70%	96.53%	91.00%

	Dec-18				Jul-18			
	Online				On-Site			
	Avg	Std Dev	Max	Min	Avg	Std Dev	Max	Min
Project Set 1	91.81%	6.80%	100%	81.00%	93.09%	3.35%	96.80%	89%
Project Set 2	Project Sets 1 and 2 were combined in this class				92.95%	5.48%	99.00%	85.20%
Cracking WiFi Project	93.41%	6.06%	99.53%	84.00%	90.32%	4.68%	96.20%	85%

Figure 5 - Small Group Project Grades – Online vs. On-Site Versions of Same Course

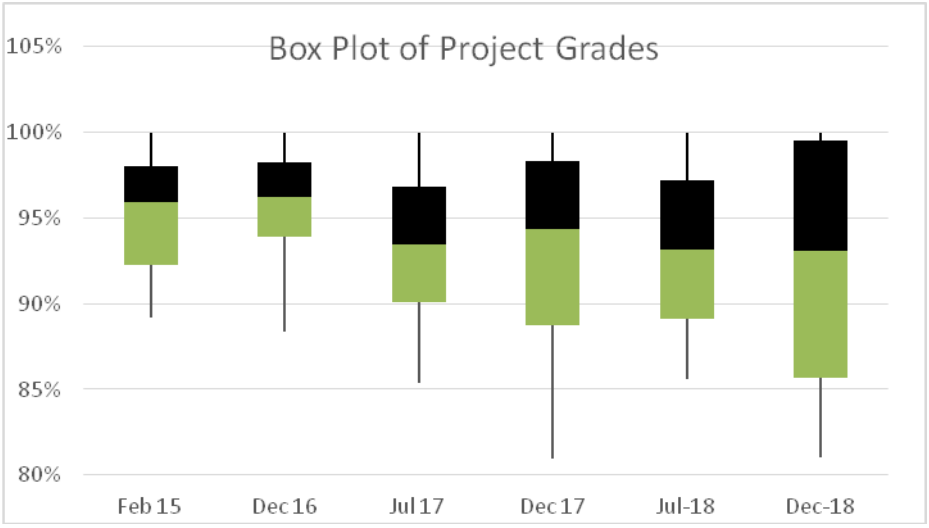

Figure 6 – Box Plot of Project Grades across Six Courses

Figure 6 shows a Box plot of project grades across the 6 different classes. Box plots are a graphical depiction allowing easy comparison of several sets of data through looking at their quartiles (McGill et al, 1978).The center of each box is the median grade, the top of the top box

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is the third quartile, and bottom of the bottom box is the first quartile, and the whiskers in Figure 6 show the maximum and minimum grades. It is clear from the boxes that there is no significant difference between student learning from small group projects in online courses and on-site courses. The process of generating a recorded presentation for online courses has leveled the playing field, so that the grades received are the same whether the course is taken online or on-site.

Conclusions

This paper has studied the impact of several innovations for online courses, and assessed the effectiveness of those innovations by comparing results across five courses: three online and two on-site for the same subject. Students like having lectures available in the form of 10-15 minute digitally recorded segments. Online students were offered synchronous sessions where the recorded material was reviewed but they did not have to attend those sessions. Some of the best students chose not to attend the synchronous sessions. On-site students found the recorded lecture segments quite useful for reviewing material they had difficulty grasping when it was first presented in a live lecture.

The mentored assignment process is effective in allowing online students to interact with other online students. Through the process of interacting with four other students (two to mentor and their two mentors), they are able to concentrate their interactions on a few other students instead of trying to interact with the whole class. Data collected from five classes confirms that quality of research, original thinking, understanding of the subject, and thoroughness of references is as good as or even better for the online students when compared with onsite students.

Results from small group projects in online courses also confirm that requiring online students to pre-record their small group presentation is effective and enables students to interact with each other asynchronously to prepare excellent recorded presentations. This is confirmed in the comparison of small group project grades for online and on-site courses.

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