

## ONLINE STATISTICS: MY COURSE EVOLUTION

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Since as one makes changes and additions to a course its form and structure may become more complex, it is only fitting to consider this the evolution of a course; evolution is the gradual development of something, especially from a simple to a more complex form. In this paper, I will discuss the evolution of my online statistics course.

I have taught twenty-two sections of MATH 117 Introduction to Statistics as an online course with the first section during Summer 2005 and the most recent section during Summer 2016; I will teach the next section of statistics online during Fall 2017.

As for any online course, various online tools and an online environment are necessary. Although many choose to use their college or university LMS as the main course web site, I have chosen to use my web site rather than the university's LMS (Blackboard) as the main course site. Why? Since the university's web server is stable and accessible to students with a simple web browser, students can always access my web site using any device – smartphone, tablet, or computer. They do not need a specialized App, for example the Blackboard App, which may or may not work with their device. In addition, since I have a backup web site on a different web server, students may access course materials using either my main web site or my backup web site as, except for the URL, these sites contain the same materials and they are identical in format and design. I post all course documents, information, resources, and assignments on my course web site; with the backup web site, course materials are always accessible. Since my web sites are open for public viewing, I cannot host a private discussion for students; a public discussion would not promote student participation as internet trolls would interfere. So, I use Blackboard as a protected environment for online discussions; Blackboard also serves as a platform for administering online quizzes, submitting assignments, and returning graded work such as quizzes, assignments, and exams. In addition, students use the online homework system that accompanies the course textbook to complete assignments providing regular practice, repetition, and immediate feedback to help students learn course topics and methods; I set the assignments for an unlimited number of attempts. Although this homework system includes a discussion board as well as the means to administer online quizzes and submit and return student work, I have chosen to use the university's LMS to protect the privacy of my students. Therefore, I use my web site, the university's LMS, and an online homework system to provide students with access to all course materials, a protected environment for student work, and the means for drill and correction, respectively.

When I taught my first section of statistics online, I had considered using only Blackboard as the course environment. Since it was the first go-around, I opted to use the three separate sites, my web site with backup, Blackboard, and the online homework system. However, a week before the final exam, I was locked out of the Blackboard site for over eight hours during one day. When I initially reported the problem to Blackboard support, I was informed that I should not be able to access the Blackboard course as I was neither enrolled in the course nor the instructor. After enlisting the help of the on-campus IT support, the Blackboard support representative who had denied my request for help earlier called to let me know that the folks at Blackboard were now working on the problem. While I was glad that none of my students experienced such a problem during the course, others have experienced Blackboard access problems since then; I am glad that none of my students have experienced problems in as great a duration as I did. Having experienced this period of lack-of-access solidified my resolve to maintain the course materials on my web site and backup web site rather than post them on Blackboard as well as maintain the access to the online homework system as a separate sign-on in order to minimize the effects of access problems.

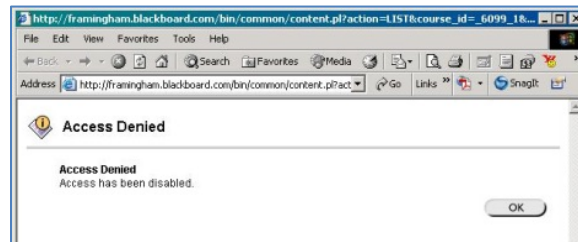


Figure 1: Blackboard “Access Denied” error message, July 11, 2005; I saved the screen capture as a reminder of the experience.

As I made changes to the course, I made changes to the format and design of the course sites. During Summer 2005, the main page of the course site on my web site included a caution that online courses are not for everyone. This caution emphasized the need to be

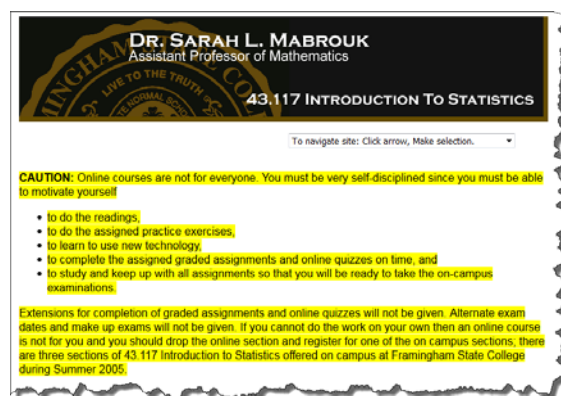


Figure 2: Main course page on my web site, Summer 2005.

self-disciplined and self-motivated in order to complete course work in a timely manner as well as able to learn to use new technology. Although this caution is important, I decided that it was too in-their-face and, thus, could be viewed as intimidating. So, I

backed-off a bit and included a friendly introduction to statistics at the beginning of the



Figure 3: Main course page on my web site, Spring 2006.

main course page starting in Spring 2006; the caution about online courses was included on another page of the course site in a more gentle manner. Since providing a caution



Figure 4: Main course page on my web site, Summer 2006.

about the differences between face-to-face and online courses is helpful to students as well as important in a course like statistics for which students do more than simply



Figure 5: Main course page on my web site, Fall 2006

express their opinions, I added a separate *Caution about Online Courses* page to the site starting in Summer 2006; I added a horizontal navigation bar below the statistics introduction as well. Since the students responded well to the information that I included on the *Caution about Online Courses* page, I have maintained and expanded this page in

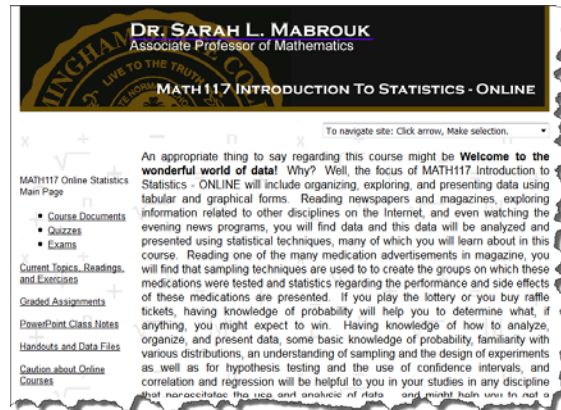


Figure 6: Main course page on my web site, Summer 2008

the course site. Since the students use Blackboard in other courses, I decided to change the navigation format on my web site: in Summer 2008, I moved the navigation menu to

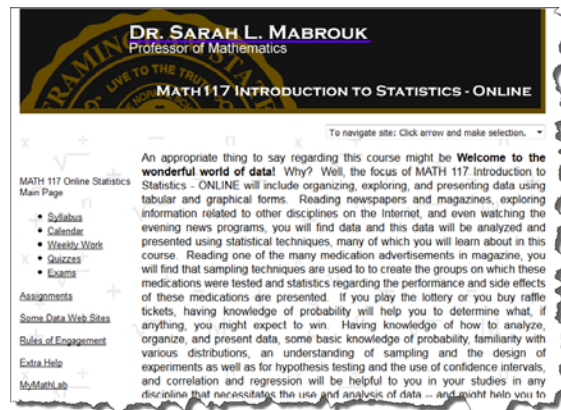


Figure 7: Main course page on my web site, Summer 2016.

the left-hand side to match Blackboard. Since I have always used text-navigation rather than button-navigation on Blackboard, this change resulted in a common navigation format for the course web site, Blackboard, and the online homework system. I have maintained this format since then.

As mentioned, all course information and resources are accessible via my web site and backup site. In addition to the *Caution about Online Courses* page, the course site includes an *Extra Help* page, a *Rules of Engagement* page, and a *Some Data Web Sites* page. The *Extra Help* page provides information about on-campus and online tutoring as well as information about office hours and making face-to-face, by-phone, and online

appointments. The *Rules of Engagement* page provides information about proper, respectful behavior in the online course environment. Via the *Some Data Web Sites* page, I provide students with access to a variety of web sites which include interesting articles and data sets which may be helpful for assignments and discussions. In addition to the syllabus, dates for quizzes and examinations, and dates and information for assignments (which are posted on the *Assignments* page), I include course *Calendar* and *Weekly Work* documents. The former includes a by-chapter and by-topic timeline for the course and how the readings and course topics fit with assignments, quizzes, and exams for students who find it helpful to have a calendar view of the course. The latter provides the details for each week's readings (handouts, PowerPoints, and textbook), practice exercises, and discussions (on Blackboard) to do and the videos (TED Talks and my videos) to watch together with how the assignments, quizzes, and exams fit into each week of the course. In short, the *Weekly Work* document serves as guide for what must be completed each week in order to stay up-to-date. In order to connect the course site to Blackboard and the online homework system, I include hyperlinks to each; each of the three sites includes direct hyperlinks to the other two.

Interaction is important for learning. I include this via office hours, online problem sessions, and online discussions via Blackboard. For the first online statistics course, office hours were held in-person on campus as well as online using Blackboard's *Virtual Office Hours*; students could call-in during office hours as well. Since I make appointments to meet with students in my face-to-face classes, I have always done the same for students in my online course but they must arrange the venue – on-campus, by-phone, or online – in advance. For the first few online courses, conducting online office hours or online appointments via Blackboard's *Virtual Office Hours* and conducting online problem sessions via Blackboard *Virtual Classroom* were less than satisfying as both were text-based. Using text-based communication does not allow one to obtain the subtle information from silences, hesitation, intonation, and tone that a voice component provides. With the addition of *Eluminate Live!* as a module of our Blackboard system, online office hours and online problem sessions became more attractive to students and more effective for me since we could discuss course material together; students enjoyed the session recording feature as well. Online office hours and online problem sessions

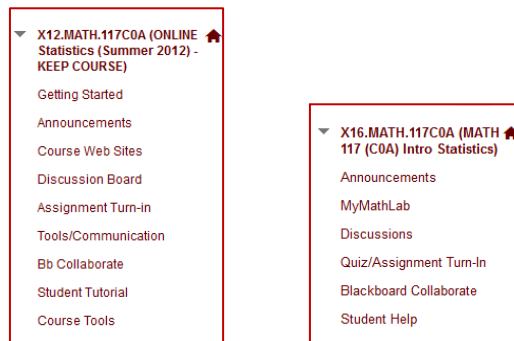


Figure 8: Blackboard Menu Summer 2012 and Summer 2016.

became even more effective with the advent of *Blackboard Collaborate* due to its better



connection and quality as well as its not timing-out participants for lack of activity. So, I made *Blackboard Collaborate* a regular component of my course starting in Summer 2012, and I have continued to use *Blackboard Collaborate* as a venue for online office

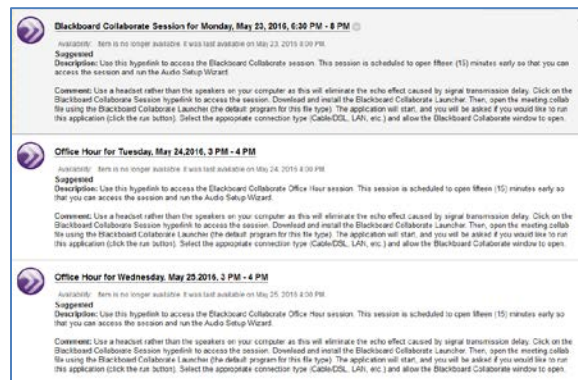


Figure 9: Blackboard Collaborate session and office hours scheduled for the beginning of the Summer 2016 course.

hours and online problem sessions for online courses and special online sessions for face-to-face courses. Online office hours and online problem sessions are scheduled in advance and listed on the *Blackboard Collaborate* page. Students access these sessions via the hyperlinks on this page, and the listing for each online office hour or online problem session disappears after the session so that students view only the current or upcoming sessions. My first online discussions were what I called *Round Robins*. These were designed to mimic in-class interaction through which students make one-step-per-student step-by-step contributions to problem solving and analysis. While the idea was sound as students learn more from problem-solving while working together, unfortunately, those who waited until the end of the posting period ruined the effect. Email reminders to post a *round* were dissatisfying for me as I believe that an instructor should not need to prod students to get them to do the work; doing so made me feel more like a nagging parent rather than a guiding professor. My next version of discussions involved each student posting unique problem as the main post and students discussing their work, providing corrections, and making comparisons via the first response, each to a unique student's main post, and a second response, the reply to the first response, as well as subsequent postings which continue the interaction. These problems were initially textbook exercises but, then, I designed unique problems related to each discussion topic. But even these unique problems did not suit my needs as I wanted the discussions to be real-world based not just real-world data-based. My solution came out of an idea I had for grabbing the attention of the students in my face-to-face classes – *statistics* (for some classes, *mathematics*) *in the news*. Initially, I added this as a final discussion to wrap-up and summarize all the course topics and methods but, upon finding this discussion to be fruitful, I used this idea to redesign the discussions. I created topic-based *statistics in the new discussions* for summary statistics, probability, confidence intervals, and hypothesis testing. For these discussions, students must find a real world application for the respective topic which was reported in the news or a journal, provide the properly formatted correct bibliographic reference for the video with accompanying

article, newspaper article, or journal (which must be accessible online), discuss the statistical methods used, and explain the analysis using meaningful terminology and correct notation. This is the main post for which each application must be unique; students cannot earn credit for use of similar scenarios from different sources, and scenarios are claimed based on the time of the post. Each *Statistics in the News* forum has a two-week period: the main post is made during the first week and the first response and second response, the interaction, are made during the second week. Use of my *Statistics in the News* forums has enhanced course interaction and enabled students to examine real-world application of the topics and methods about which they are learning throughout the course. In addition to these forums, there are two discussions that I have used in every online statistics course, *Meet Me Online!* and *What is/are Statistics/statistics???*. Via the *Meet Me Online!* forum, students introduce themselves to the other members of the course and share information about their programs of study, desired future careers, and reasons for taking the course; this one-week forum helps students to become comfortable with one another and see that they have similar goals. For the *What is/are Statistics/statistics???* discussion, discourse revolves around statistics as related to and used in their programs of study and desired future careers, and they must do research in order to provide relevant examples; as with the *Statistics in the News* discussions, proper references are required for these examples. The *What is/are Statistics/statistics???* discussion, which serves as a gateway to the *Statistics in the News* discussions, is two weeks in duration with the main post made during the first week and the interaction, first and second response as well as additional replies, made during the second week; as with all my discussions, each student must post a first response to a unique student's main post so that each student receives a first response, and interaction continues from there. All posts on the forums must be direct, not as attached files so that posts are readable via web browsers and the Blackboard App and so that no one is barred from participation based on program access. While I have considered allowing students to make discussion posting using video or audio recordings, text-based postings are more useful for comparison and demonstration of the students' understanding of meaningful terminology and proper notation. The student-to-student and student-faculty interaction via the discussion forums, online office hours, and online problem sessions are a virtual equivalent to interactions experienced in face-to-face courses, providing opportunities to discuss course material and ask questions both of which are necessary for learning.

Course assignments have been by-hand and online. At least one assignment for each course has involved by-hand work and analysis for a data set; I use real-world data throughout the course. Such assignments were originally submitted by-mail or in-person as the majority of students did not have access to a scanner; I used to send the graded assignments back to the students by mail at my expense since using the campus mail delayed receipt of graded work and some students did not have a sufficiently stable internet connection to allow them to download scanned graded assignments. Now, handwritten assignments are submitted (and returned) via Blackboard in PDF format as smartphones and tablets enable students to take pictures of each page of their work and save these pictures in PDF format; there are sites at which students may save collections of images to single-file PDF format as well. One handwritten data analysis assignment

that I use on a regular basis involves creating box plots and stemplots for an eight-variable (four quantitative and four qualitative) data set for thirty-nine mammals. The data for the variables have interesting characteristics which help students to understand how to interpret the box plots, modified box plots, and different types of stemplots that they encounter throughout the course and may come across in the future. I have used a *History of Statistics* assignment to help students to understand that Statistics was created based on the need to analyze and present information by those in a variety of disciplines rather than by mathematicians. Many are surprised that, for example, a nurse interested in improving hospital conditions and decreasing mortality rates (Florence Nightingale), a chemist trying to maintain quality and consistency in batches of beer (William Sealy Gosset), and someone curious about heredity traits in sweet peas (Sir Francis Galton) could develop some of the methods for data analysis and presentation that they are studying in their statistics course. For the *History of Statistics* assignment, students select a unique statistician (from my list), research her/his life and work, and share what they learned about their statisticians via online presentations and a discussion. Then, since practice, repetition, and immediate feedback are crucial for learning about and to apply statistical methods, I have assignments for each course topic that students complete via the online homework system. These assignments are set so that students have an unlimited number of attempts until the due date/time, and I reopen these assignments at key times throughout the course so that students may obtain additional practice and, thereby, increase their scores on assignments; truth be told, reopening the assignment is nothing more than a dirty trick (as I like to call it) to get students to study before an exam or the final exam. All assignments are geared towards helping students to learn course material and to understand how they may apply the topics and methods that they are studying in their programs of study and in their future careers.

Quizzes are administered or submitted via Blackboard. Most quizzes are administered using the Blackboard quizzing facility but some are taken by-hand. By-hand quizzes for first few online statistics courses were submitted by mail or on-campus, and graded quizzes were returned by-mail at my expense in order to minimize delivery time. Handwritten quizzes are now submitted in PDF format via Blackboard similar to handwritten assignments, and graded quizzes with handwritten comments are scanned to PDF format and upload to Blackboard for return to students. Blackboard quizzes are not limited to multiple-choice, multiple-response, fill-in the blank, or matching questions but rather include essay questions for which students are expected to provide all work, analysis, and explanation in order to earn credit. Since an equation editor is available among the tools provided for essay questions, students have the means to use appropriate notation when presenting their work and analysis. I set up all Blackboard quizzes so that any basic (multiple-choice, multiple-response, fill-in the blank, or matching) questions are immediately graded, and I provided a full solution with explanation for each question; for simple questions, feedback is provided based on whether or not responses are correct. When I grade Blackboard quizzes, I examine the responses for simple questions, adjusting the number of points earned when the format of a response is misunderstood by the quiz facility and providing individual feedback based on each response, and I provide guidance and correction for each essay question response. As one who evaluates



handwritten assignments, quizzes, and exams on a one-question-at-a-time basis so that the comments and number of points earned by students are consistent, I find grading Blackboard quizzes to be frustrating and more time consuming. Since Blackboard does not provide the mean for grading (comments, correction, feedback, and points earned) one question at a time, I print the “collected” quiz responses, evaluate the responses for each quiz question by-hand, and, then, enter the comments, corrections, feedback, and number of points earned for each question for the individual quizzes. For all quizzes, it is important for students to receive immediate feedback so that they can ask relevant questions and revise their understanding.

Examinations are administered on campus. When I was asked to teach the first section of statistics online during Summer 2005, the department chair stated that the exams must be administered on campus so that we would know who was actually taking the exams. This requirement has continued since then. During the first few online statistics courses, exams were returned by mail, at my expense, in order to minimize mailing time. In addition, I would photocopy each exam so that I could meet with students (in-person, by-phone, or online) individually to discuss any questions they may have about their work on exams; having a copy of each exam made it possible for me to see each student’s work as we discussed their questions. Now, I scan graded exams to PDF format and post the exams on Blackboard for the students to download; I continue to meet with students (in-person, by-phone, and online) individually to discuss any questions they may have about their work on exams. Since questions analysis for confidence intervals and hypothesis testing related to real-world data are more involved and require more time, I administer the third exam as a limited-access take-home problem set. This exam is available for a limited time period and must be downloaded, worked, scanned to PDF format, and submitted via Blackboard before the deadline; I use a similar setup for by-hand assignments and by-hand quizzes. As with quizzes and assignments, I have a quick turn-around time for grading so that students receive their graded exams and feedback as quickly as possible to facilitate learning and revision of understanding.

Initial course materials were text-based but, then, supplemented with videos that accompany the textbook followed by TED Talks and videos that I created. During the first few sections of online statistics, I used PowerPoint lecture and handouts that I created as well as the textbook; the PowerPoint lectures and handouts were and continue to be posted on my web site in PDF format. The handouts, now seven in all, are, for the most part, short and focused on a particular topic to provide guidance and cautions; to highlight the similarity between the formulas for standard deviation and linear regression, I created a longer, combined handout which includes calculation tables to demonstrate and compare the use of each formula. Each PowerPoint lecture – now, a total of twenty-seven – focuses on a different topic and includes examples. The *Hypothesis Testing* PowerPoint lecture is the longest (375 slides) but it is designed to take students step-by-step through the analysis of several problems by adding one step at a time to guide them through the process, analysis, and interpretation of results; the relevant problem/question is displayed on each slide throughout its examination so that students can make connections between the questions they are analyzing and the methods that they are

using. Since many students are visual learners or learn through watching and imitating, I included the videos accompanying the textbook which are available via the online homework system as a resource for students. Unfortunately, many of the students did not like the manner in which the videos were recorded, and I found errors in some as well; an added problem is that these videos are limited in scope and do not use real-world data. To align with my *Statistics in the News* discussions, I added sixteen TED Talks to provide “food for thought” regarding the application of statistical methods. I included three TED Talks for the first four modules (an introduction to statistics; data collection, sampling, and experimental design; organizing data and summarizing data graphically; and summarizing data numerically) and four TED Talks for the last module (analyzing and representing the relationship between two variables). Each TED Talk goes beyond-the-basics, provides interesting applications of statistics in the real world, and some advanced topics so that students can understand how statistics can be used in different areas. Since I want students to have the opportunity to work through the analysis of various data sets and interpret their results, I began making my own videos. While some videos have a PowerPoint base, the majority of my videos were recorded “live” while working on my tablet PC. Each video has full narration and full explanation of the analysis; I create my videos using TechSmith’s *Camtasia*. My videos have been well-received and appreciated by my students. My initial videos included a Blackboard tour and a tour of the course website. Now, I create this pair of videos for *each* online statistics course, and I embed each video in the *Getting Started* announcement that I post on Blackboard at the start of the course. While I have included on-screen captions for these videos in the past, doing so obscures parts environment (Blackboard or my web site) that I want students to view. Since this text component is important in regards to accessible design, I post the *full* transcript for each video in the *Getting Started* announcement. The Blackboard and course web site tours provide an overview for the course, inform students where to find course materials, and guide students on the purpose for each site; in short, these videos provide information about how to get started in the course. The titles for my sixteen data analysis based videos are listed below. The videos marked with an asterisk (\*) have a PowerPoint base and the rest were recorded “live”

- |   |  |
|---|--|
| • Determining the Five-Number Summary                   | • Creating Stem and Leaf Plots with Split Stems        |
| • Standard Deviation*                                   | • Probability  |
| • Two More Examples for Calculating Standard Deviation* | • More Probability                                     |
| • Creating Box Plots                                    | • Basic Counting Techniques*                           |
| • Creating Modified Box Plots                           | • Normal Distribution                                  |
| • Creating Stem and Leaf Plots                          | • Binomial Probability (includes Normal approximation) |
| • Creating Back-to-Back Stem and Leaf Plots             | • Sampling Distributions                               |
|   | • Confidence Intervals                                 |
|   | • Hypothesis Testing                                   |

Figure 10: List of my sixteen data analysis based videos.

while writing on my tablet PC. While the between six minutes and eight minutes per

video “rule” may work for the Blackboard and course web site tours, this “rule” makes no sense for problem-solving and data analysis of real-world data: the discussion of the context, the analysis of data, performing calculations, and interpretation of results in-context for real-world data requires more than between six minutes and eight minutes. So, the shortest of these videos is *Creating Box Plots* (5:08 minutes) and the longest is *Hypothesis Testing* (1:15:24 hours); this is appropriate as creating Box plots requires considerably less time than performing hypothesis testing for several real-world scenarios. My videos, accessible via the *Weekly Work* document, are hosted on YouTube so that students can view them using any device – smartphone, tablet, or computer. While I have considered posting my videos on Blackboard and using SCORM to monitor the extent to which students watch them or to reward students for watching up to 95 percent of each video, this truly serves no purpose as students can open such videos on Blackboard and let them run *unattended* until the end. So, I have chosen to host my videos on YouTube so that students have unlimited access anywhere and use the videos at any time. Finally, students have access to the interactive workbooks that I create using MS Excel. These workbooks enable students to explore concepts such as classification of distribution types based on characteristics displayed in histograms or how changing one data value may affect the value of the mean, median, and/or outliers for a distribution, provide an infinite number of practice problems for determining the five-number summary, allow students to explore probability for a large number (up to 25,000) of tosses of a fair coin or rolls of a fair die, compare normal distributions with different means and standard deviations, graphically compare probability density functions, and check their calculations and conclusions for applications of the Normal distribution, determining confidence intervals or analysis for hypothesis testing. I chose to use MS Excel as a platform since no internet connection is required and since MS Excel is readily-available, widely-used program. For my sabbatical project, I am designing Mac-equivalents for each of my interactive workbooks so that students can use these workbooks on both PC and Mac; while Active-X controls work on PCs, they do not work on Macs. Therefore, course materials include text-based resources, videos, and tools for exploration.

My next steps include adding more videos and obtaining Quality Matters approval for my course. I plan to add some summary topic video lectures as I believe that these will be helpful for both starting topics as well as reviewing before examinations. I am interested in the Quality Matters approval since it would help the students to know that they are taking a quality-based online course which meets the needs of a variety of learners in the online environment; the Quality Matters approval is good for the University as well.

Overall, I have enjoyed designing and expanding my online statistics course. Developing new ways in which students can explore, learn about, and apply statistics is exciting and rewarding. Unfortunately, encountering students who view online courses as involving little more than writing a paper or expressing their opinions on a discussion board as a result of online “courses” that they have taken in other disciplines is frustrating as one must practice and “do” statistics in order to learn and be able to apply statistical methods in the real-world. Changing from a text-based course to a mix of text and video resources

has been beneficial for students, and the changes that I have implemented to online discussions has increased interaction and changed the emphasis of discussions from problems to real-world applications. Developments in LMS tools such as the availability of *Blackboard Collaborate* which includes, among other things, components for voice, video, messaging, common whiteboard, PowerPoint, web browser sharing, and real-time voting have improved the quality of online interaction making it possible for online office hours and online problem sessions more closely approximate the interactions experienced in face-to-face courses. Since being responsive to students, encouraging questions, and making connections with those experiencing difficulty are important, I plan to continue to use in-person, by-phone, and online appointments as well as regular contact via email. Being available for extra help, fostering an environment in which questions are welcomed and valued, and maintaining contact with students enables me to guide them to learn, help them to complete work in a timely manner, discourage procrastination, and help them to succeed in the course. Continuing the use of real-world data and a focus on real-life scenarios throughout the course is a must as the use of contrived data sets cannot prepare students for data analysis in the real-world: real-world data analysis requires the ability to analyze and discuss big-data in-context with results interpreted using clear language in a meaningful way. While my course has evolved to become more complicated to maintain and update, the resources that I provide make learning statistics more accessible for students and creating new resources keep me in-touch with their needs and their different learning styles. New technologies affect our world and, of course, education, and how we employ technology in our courses and use technology to enhance learning can be viewed as a burden or a blessing: I chose to embrace new technologies and harness them for use in my courses, furthering my ongoing course evolution.