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Selecting Technology to Promote Learning in an Online Introductory Statistics Course

1. LITERATURE REVIEW

For more than a decade, statistics educators have been researching how to implement statistics courses online and determining whether there is a difference between online courses and traditional courses. Stephenson (2001) compared students who watched videotaped lectures with students in the live audience. The lectures consisted of Powerpoint and overhead slides. The lectures also included hands-on activities.

> In summary, there was very little difference between on and off campus students in terms of performance in the courses. The off campus students tended to rate the course about the same as the on campus students except in those semesters where the number of off campus students was quite large and there were logistical problems with the delivery of the course or with computing (p. 11).

Utts (2003) compared a traditional course to a hybrid course (partially online) that met only once a week. She found that "performance of students in the hybrid course equaled that of traditional students, but students in the hybrid were slightly less positive in their subjective evaluation of the course" (p. 1). Dutton and Dutton (2005) discussed a comparison of online and traditional students. The course included "40 lessons covering the material" (p. 4) on the course website, but no further explanation was given. They concluded:

> Finally, we looked at the comparisons of academic performance. We performed regressions to identify which factors helped predict success in the course. The major result here was that students in the online section had higher academic performance, even when we controlled for other important variables. The difference in performance ranged from 3 to more than 8 percentage points in grades and was statistically significant (p. 20).

Tudor (2006) discussed a course for public health students. This course included a voice over Powerpoint slides and quizzes for self-assessment. The quizzes were static quizzes on Word files with answers supplied. She did include discussion board assignments in her course, but concluded that ". . . , it appears that the effectiveness of online discussion in a statistics class is still debatable. The biggest factors affecting their success may be the topic of discussion and the quality of the questions" (p. 7).

Everson and Garfield discuss "the way in which the GAISE recommendations have been implemented in one key component of the online course: small-group discussion" (2008, abstract). The Guidelines for Assessment and Instruction in Statistics Education (GAISE) are a series of guidelines for educators teaching statistics in the United States (Aliaga, Cobb, Cuff, Garfield, Gould, Lock, Moore, Rossman, Stephenson, Utts, Velleman, & Witmer, 2005). The article by Everson and Garfield provides a model of how future

online courses should be developed to support the GAISE. The GAISE guidelines recommend "that instructors

1) Emphasize statistical literacy and develop statistical thinking;
2) Use real data;
3) Stress conceptual understanding rather than mere knowledge of procedures;
4) Foster active learning in the classroom;
5) Use technology for developing conceptual understanding and analyzing data;
6) Use assessments to improve and evaluate student learning."

Mills and Raju (2011) summarize and compare twenty articles about online courses in statistics over the past decade. Mills and Ragu assert that:

In the middle to latter part of this decade, more importance was and has been placed on:
- Selecting "appropriate" uses of technology for the online statistics environment;
- Improving interaction among students and the instructor;
- Enhancing the overall learning experience for online students;
- Conducting formative and summative evaluations to carefully monitor the teaching and learning process. (p. 21)

In addition to statistical education literature, general education literature can also tell us about the important components of an online course. The text, "The Online Teaching Survival Guide: Simple and Practical Pedagogical Tips", contains a list of 10 best practices for online teaching:

- Best Practice 1: Be present at the course site
- Best Practice 2: Create a supportive online course community
- Best Practice 3: Develop a set of explicit expectations for your learners and yourself as to how you will communicate and how much time students should be working on the course each week
- Best Practice 4: Use a variety of large group, small group, and individual work experiences
- Best Practice 5: Use synchronous and asynchronous activities
- Best Practice 6: Ask for informal feedback early in the term
- Best Practice 7: Prepare discussion posts that invite responses, questions, discussions, and reflections
- Best Practice 8: Search out and use content resources that are available in digital format if possible
- Best Practice 9: Combine core concept learning with customized and personalized learning
- Best Practice 10: Plan a good closing and wrap activity for the course (Boettcher, J. and Conrad, R., 2010, line 1023)

These best practices describe the necessity of building community in an online course as well as the need for a variety of assignments. The online course described later in this paper was specifically designed in order to reflect GAISE guidelines as well as the best practices.

2. IMPORTANT QUESTIONS TO CONSIDER WHEN SELECTING A TECHNOLOGY

The purpose of this paper is to help other instructors who are asked to teach an online course for the first time to learn from the author's experiences of creating that first online statistics course. When an instructor is asked to teach their first course online, there are several questions that must be answered:

1. Where will the course be located?
2. How will the course be conducted?
3. How will students and the instructor communicate?
4. How will high stakes assessments be administered in the course?
5. What additional requirements might an instructor need to run an online course?

The paper will answer these questions using various forms of technology that were used to implement an online Introduction to Statistics I course. Some of the technologies that will be discussed include content building software, computer/video screen capture programs, interactive communication programs, hardware that was used and the grading of high stakes testing. This paper will first discuss general answers to these questions and what features should be considered when choosing technology. The paper will then discuss the technology that the instructor/author chose. At the end of the paper, several recommendations will be made for instructors who plan on teaching an online statistics course for the first time.

Where will the course be located? For the first question, a decision has to be made about where the content of the course will reside. This location can be either a course management system like Blackboard or a publisher maintained website like MyStatlab. When considering what type of content management system to use, price, ease of use, and helpdesk options should be considered. Course management systems come in several different pricing systems. Some systems are maintained by publishers and the cost of the system is passed on to the student, but a benefit of these publisher systems is that they come preloaded with content. Other systems are open license software like Sakai or Moodle, which are free to students. Some colleges and universities also have course management systems that are maintained by the school at no additional cost to the student. The course management systems also need to be easy to navigate and easy to maintain by the instructor. The material should transfer from semester to semester, so the entire course does not have to be reloaded each semester. The helpdesk options should also be considered for each system. Instructors and students need to have the ability to easily contact a technical support staff in case there is a problem with the software.

How will the course be conducted? **In a traditional classroom setting, students typically** listen to lectures and might do hands on activities or group work. When the course is moved completely online, what replaces these lectures and activities? The content can be written or recorded audio or video for the students. The content of the course can be received synchronously or asynchronously. The content can be publisher content or created by the instructor.

How will the students and instructors communicate? In a traditional classroom, the students can speak with the instructor before or after class or visit during office hours.

Online, electronic options need to be available for the students to talk to the instructor. These methods of communication should be easy to use and available to all students regardless of their economic background. There are many options for communication: email, discussion boards, chat rooms, and synchronous meetings online using Skype, Adobe Connect or similar programs. In a completely online environment it is easy for a student to feel isolated. It is immediately apparent to students in a traditional classroom that there are other students experiencing the course – they are not alone. This is not the case in an online course. It is not immediately apparent that other students are listening to the same instructor and completing the same activities. It is important to give the students a sense that they are a part of a group. There are several ways to promote a community feeling in the course; through the use of a chat room, discussion board, emails from the instructor and even group work.

How will high stakes assessments be administered in the course? There are also considerations that need to be made about assessment as the options are vast and many. Instructors need to decide if they are going to write their own assessments or have the option to create their own. Many publishers offer automatically generated tests, quizzes and homework problems. Whereas many course management systems like Moodle, Blackboard, and Sakai have the option for instructors to create their own assessments. Additionally, the instructor also needs to determine how to handle high stakes testing. For a completely online course, there are several options including using testing centers at various locations or using an online test proctoring service. For a course that is not required to be a completely online course, it is possible to have high stakes testing occur on site at campus.

What additional requirements might I need to run an online course? In order to meet all of the requirements from the previous systems, it may be necessary to acquire additional computer hardware or software. Sometimes a wireless microphone or tablet laptop computer may be needed. A tablet PC is helpful because it allows instructors to write on the screen similarly to how they would write on the blackboard or overhead transparency in class. It is important to have a fast computer to be able to handle the load of recording the handwriting on the tablet PC as well as to edit the recorded videos if needed. When considering a microphone, the quality of the sound, ease of use and comfort should be considered.

3 DISCUSSION ON THE ONLINE STATISTICS COURSE

3.1 General Course Description

This research was conducted with a class of 67 undergraduates at a large research institute in the United States. The course was taught during the summer over a period of six weeks. The stipulation made by the university was that the students would not be required to come to campus for any portion of the class and therefore everything had to be done completely online. There were multiple areas of assessment in the course: exams, daily lesson quizzes, chapter quizzes, small group discussion board assignments, daily homework and a final project. Each of these assignments utilized technology at some level.

3.2 Class Demographics

Institutional data were collected on the year in school, gender, age and their home college of the students. See the below tables for a brief overview of the demographics of students who completed the course.

Table 1. Class Demographics: Year In School

Year In School	Non-Degree	Freshman	Sophomore	Junior	Senior
Percent	2%	6%	39%	40%	13%

Table 2. Class Demographics: Home College of their Major

College	Percent
Liberal Arts and Science	60%
Agriculture	10%
Business Administration	8%
Health and Human Performance, Journalism	6% each
Engineering; Public Health and Health Professions	3% each
Fine Arts; Education	2% each

Table 3. Class Demographics: Gender

Gender	Percent
Male	19%
Female	81%

Table 4. Class Demographics: Age

Age	18-20	21-23	24-26	26+
Percent	89%	8%	2%	2%

3.3 Implementation of Technology

Technology plays a vital role in an online course; therefore, the technology should be there to assist the course not be a hindrance. The subject matter of the course should be of primary importance for the students, not the technology used to deliver the course. Each of the five questions about the use of technology in the course will now be discussed in greater depth.

Where will the course be located? For our university, the instructor had two options for a course management system, MyStatLab and Sakai. MyStatLab is the course management system that comes with the textbook used in the course. Sakai is an open source course management system that is used by the university. The instructor wanted the flexibility that came with the university operated course management system, so for this course, the lessons, syllabus, quizzes, tests, and discussion board assignments were all located in Sakai, an open source content management system. Sakai did not have the option for the

numbers in each question to change for each student or the ability to give multi-level feedback at each step of the problem. Therefore, the textbook publisher's MyStatLab website was used by the students for homework assignments. The homework problems accompanied the textbook, *Statistics: The Art and Science of Learning from Data* by Agresti and Franklin (2009). For each lesson, students were required to complete a homework assignment in MyStatLab. The lessons and homework problems were due within three weekdays of being assigned.

From the instructor's point of view, the assignments were easy to select and assign. The instant feedback that the students received was a nice feature. The only problem that was experienced during the semester was that in one question it was necessary to get an exact p-value from a *t*-distribution with a high degree of freedom. This was a problem because students were taught to use a table to get an approximate value of the p-value. The students were shown how to use an applet to solve this problem. The students adapted to the use of the applet very quickly and there were no other issues. The syllabus was later modified to discuss both the use of the table and the use of an applet to get p-values.

How will the course be conducted? When a course occurs in a traditional classroom, usually the students experience lectures and/or performs learning activities. How do you do these things in an online course?

 How to deliver content is often the first area of need that instructors must satisfy for an online course. The instructor used a combination of video tutorials and online activities to replace the lectures. These were combined into lessons built in SoftChalk, a lesson building software package that can be used to build lessons with videos, short quizzes, and flash-based activities. The paper will briefly discuss the method used to capture the videos and then conduct an in depth discussion about building lessons.

Camtasia Relay was used for video capture for the course because it was supported by the university and video storage was free. The limitation of the Camtasia Relay software was that our campus-supported version did not allow for much additional editing of the video beyond setting start and end times. A more advanced version of Camtasia is available with full editing features, but the instructor did not have that program available. Additionally, for Mac users an extra program called Flip4Mac had to be downloaded so that the students could watch the videos. Otherwise, Camtasia Relay was very easy to use and the instructor did not need in-depth knowledge of how to store streaming video. The post survey for the class showed that one student said that she watched 0 of the videos, one watched about 60 percent and the remaining 20 students who answered the survey watched all of the videos.

SoftChalk was used to create a course website built by the instructor that covered 24 detailed lessons spanning 143 web pages and included complete topic explanations, 254 quiz questions, and 128 short instructor videos. The lessons also contained 22 activities including flash-based dynamic study tools written in SoftChalk, online applets and exercise problems for the students to solve using StatCrunch. The SoftChalk lessons were written by the instructor and were meant to be completely interactive. The lessons started with a list of about 3 to 8 objectives that the student should master for that day. The lesson then stepped the student through learning each of those objectives by first giving an explanation of why the objective is important and how it relates to the other material in the course. After the lesson objectives was a video or a series of videos to explain the main concepts of those objectives. Most of these videos were short, between five to ten

minutes, but a few were a little longer to fully explain a complex concept. Following the video(s) there was usually either a quiz exercise, or flash-based study tool such as flashcards that helped the student test their knowledge about what they had just learned on the video. For some objectives the students were asked to step through a series of procedures in a statistical applet in order for them to see the concept in action. Each day of the course the students were required to complete a lesson on a particular topic.

The SoftChalk software package (Version 6) was chosen because it was easy to use and little additional instructor training was needed. SoftChalk made it very easy to insert graphics, videos, sound clips, and webpages. It was also possible to test the students on what they had learned, prepare flashcards of important topics for the students to use to study and even to make games for students to match terms to definitions. For example, the students were asked to match the properties of the binomial and the normal distribution with their respective distributions. The students' participation in these activities was recorded and included in their grades. This ensured that the student actually completed the activities and hopefully reached a higher level of engagement with the material.

The university supported the use of Adobe Dreamweaver or SoftChalk; however, Dreamweaver would have required much more extensive training for the instructor. Additionally, Dreamweaver did not have the ability to include graded interactive questions in the lessons so the students could not test their knowledge as they worked on the material. Since SoftChalk allowed for the course to have a more interactive feel, SoftChalk was chosen to deliver the material.

One of the first lessons of the course discusses "Measures of Center, Spread and Position". Figure 1 shows the introduction of this lesson. The lesson is structured so that it starts with a histogram of the number of hits by the US National League Baseball teams in the 2009 season. There is then a brief discussion about why it would be important to quantify the measure of center, spread and position.

The objectives of the day are then presented:

1) Compute and define the mean, median, and mode;
2) Describe the effects of outliers on the mean and median;
3) Be able to find the median from a stem and leaf plot;
4) Be able to compute and define the measures of spread;
5) Be able to use the empirical rule and know when it is correct to use it;
6) Be able to compute and define the quartiles and to be able to use the quartiles to create boxplots;
7) Be able to use StatCrunch to make graphs and compute summary statistics.

On the next page of the lesson, the first objective is discussed with a short tutorial that explains the definitions of the mean, median and mode as well as examples of finding the mean and median of two data sets. The students are then asked to complete a quiz where they have to find the mean and median of a data set in addition to matching the terms mean, median and mode with their definitions.

For the second objective, the students are asked to explore the effect of an outlier on the mean and median by playing with an applet designed by the publisher of the textbook.

The students are then quizzed on their findings. For the third objective the students are reminded about the stem and leaf plot that they learned about in a previous lesson as seen in Figure 2. The students then watch a short video that shows them how to compute the median from a stem and leaf plot from Minitab, a statistical software package. The students are then asked to find the median from another stem and leaf plot.
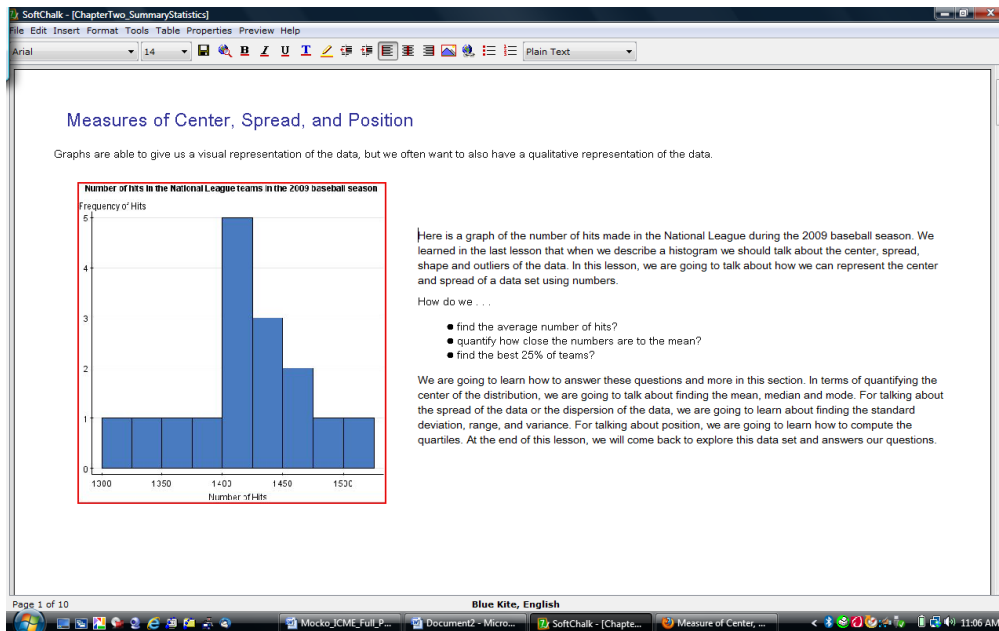

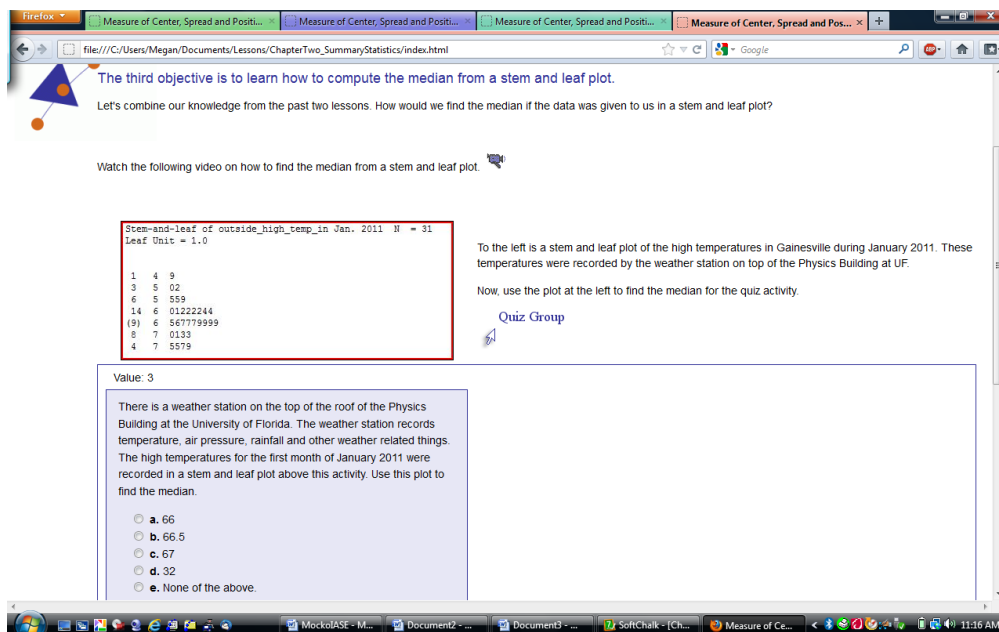Figure 1. First Page of Lesson in SoftChalk

Figure 2. Third Objective Interactive Quiz Questions with Stem and Leaf Plot

or the fourth objective the students are shown two dot plots that have the same mean and median, but have quite different spreads as seen in Figure 3 below. This demonstrates

why it is also important to talk about measures of spread. The measures of variance, standard deviation and range are discussed in a short video and then the students are asked to compute these values for a data set as well as to predict the effect of an outlier on these measures.
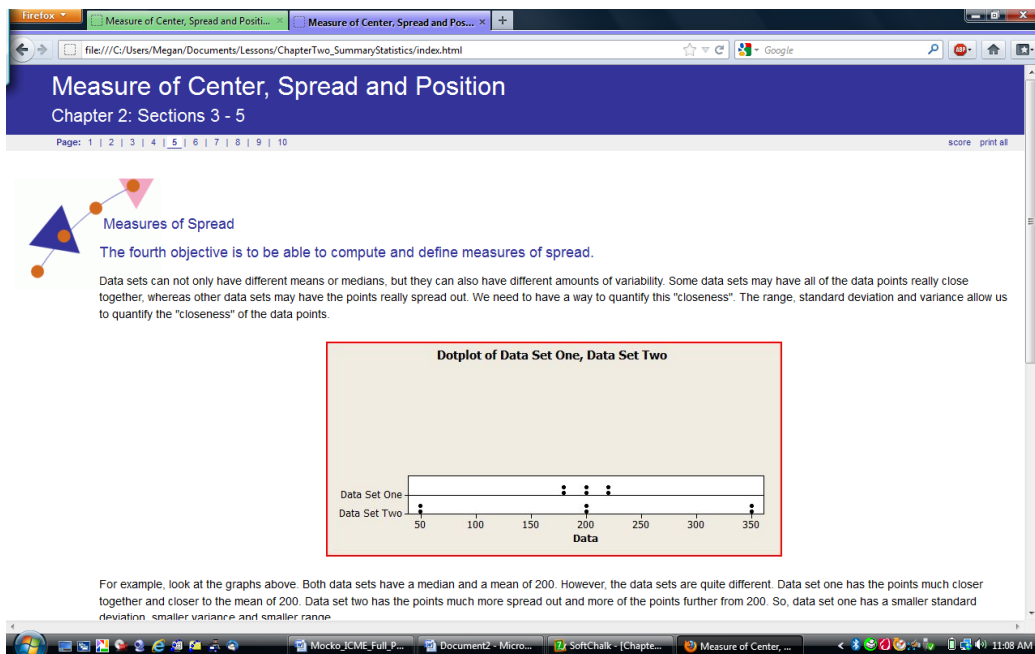

Figure 3. Fourth Objective on Measures of Spread

For the fifth objective, the empirical rule is explained in a short video and the students are asked to answer a brief question about the rule. Material on the sixth objective includes two short videos, one of the videos shows how to compute the quartiles from a set of the data and the other video shows how to use the quartiles to make boxplots. Additional discussion is given on how to interpret and read boxplots. The material on this objective finishes with the students answering three questions which require them to compare side-by-side boxplots.

On the next page the students see a small cartoon from the CAUSE website to break up the lesson a little bit. The last objective discusses the fact that computers are very important to statisticians and that in this course the students will see output from Minitab and would work with StatCrunch on the web. They are then asked to watch a video by Webster West, the creator of StatCrunch. After the watching the video, the students are asked to use StatCrunch to analyze a data set about lobster fishermen from the StatCrunch database. The last page of the lesson reviews the important concepts that they have learned.

From an instructor's point of view, SoftChalk was easy to use and allowed for a lot of flexibility in terms of activities that could be used to engage the students such as matching questions, flashcards, and linking to applets. The newest version of SoftChalk, SoftChalk Cloud, allows for lessons to be completed on smart phones and tablets. This

version also has activities that do not depend on the use of Flash software to run the activities.

Most students did not have any problem using the lessons. Initially, some students using Google's Chrome browser had problems; however, after switching to another browser those problems were resolved. Additionally, a few students had to install Flash player software on their computer in order to participate in some of the lessons. One student had a lot of problems getting the lessons beyond the first one to appear. The SoftChalk helpdesk worked with her and was able to determine that the student's very slow connection speed and computer were the issue. The helpdesk recommend that instead of bundling the 24 lessons it might be better to bundle them into two sets of about twelve lessons. For later versions of the course, the instructor bundled each lesson separately to avoid this problem. Because of the flexibility of the online activities, students can complete them on their own schedule. Most of the students completed the lessons with only a few missing one or two lessons (Table 4).

Table 4. Percent of Lessons Not Completed

Lessons Missed	0	1	2	3	4 or more
Percent	71%	13%	6%	3%	4%

How will the students and the instructor communicate? Communication between the student and the teacher as well as communication among students is critical for a good learning environment. Several forms of communication programs will be discussed including email, programs within Sakai (the course management system), a video capture program called Jing! and Elluminate by Blackboard.

The students were sent listserv emails almost every day of the course reminding them of upcoming deadlines or giving additional instructions. The students were also told to email questions about grades or other personnel issues directly to the instructor. To help encourage students to write to an instructor during the term, a minimal amount of points could be given to the student for sending an email to the instructor; however, this was not done during this course. In the syllabus, the instructor requested that students post all questions about the content of the course and the administration of the course such as questions about when an assignment was due, on the Q/A board. However, the instructor did not adhere firmly to that rule. The students simply seemed more comfortable asking the instructor questions directly via email.

Sakai is an open source course management system operated by the university that includes a text chat room and discussion board. The chat program in Sakai was another primary mode of communication. The chat function was easy to use and simply required typing. The instructor had initially thought that not having a whiteboard in the chat function would be limiting, but this did not become an issue. In the few cases when a whiteboard was needed, the instructor simply made a short video using Camtasia Relay and posted it for the students. The students seemed to feel very comfortable in the Sakai chat environment. On the day before the project was due, the instructor spent almost ten hours chatting with students about the impending project.

Elluminate was another communication program that was used briefly in the course. The Elluminate software allows instructors to conduct online office hours with a package that includes video chat, text chat, and an interactive whiteboard. It is possible for multiple

users to speak and to write/draw on the white board. Additionally, it was possible for students to be polled about a concept or simply asked to raise their hand. Although the program had many capabilities, it was very hard to use. There were too many buttons and options that needed to be understood by all users and it was too difficult to operate the program and teach at the same time.

The initial plan for online office hours for the course was to use the Sakai Chat room and then to transition to Elluminate. Since the students felt so comfortable in Sakai chat room, the instructor delayed the transition to Elluminate. The Elluminate software was used several times for question and answer sessions but both students and the instructor found the environment cumbersome to work in and several times it was not possible to get the microphone to work on the student's computer. The instructor felt that there had to be an easier platform to communicate with online students because when it was used, the Elluminate software had become the primary focus rather than the course material.

The other video capture program used was Jing! and it was selected for the student's projects because it was free and easily accessible online for students. Jing! allowed the students to give verbal presentations about their projects. The main limitation of Jing! was that it only allowed for recorded videos less than five minutes long. Since the projects for the course only required a five minute presentation, this worked very well. A few students initially had issues understanding how the program worked and were resistant to learning a new software program by this point in the semester. However, after they were pointed to the help tutorials on Jing!'s website, they were quickly able to figure out how to make the software work. Only one student ended up using a video recorder instead of Jing! due to technical issues. Afterwards several students noted how easy the program was to use and how they planned on using it in the future.

The course also used the discussion board in Sakai. The discussion board in Sakai was used for two functions: as a question and answer board and as a small group discussion board. Students were encouraged to post questions about the content of the course and general administration issues on the question and answer discussion board. The small group discussion board was used for discussion between randomly selected groups of about eight students. The students were asked to complete five activities during the six week semester. The first activity was for the students to introduce themselves to the group and then to reply to the introductions of at least three other students. The second activity was for the group to select three articles from the internet that contained information about an experiment and/or survey. The students were then asked to identify various aspects of the study such as the explanatory and response variable and to discuss what aspects of the experiment/survey were good and what could be improved. The group was then asked to rank each of the three surveys/experiments in terms of quality and adherence to the good survey/experimental protocol that they established.

The third activity was for them to conduct a lesson style called a Four Corner Debate that has the students debate a particular concept. The idea for a Four Corner Debate came from the talk by Michelle Everson and Jackie Miller at USCOTS 2011 (For more information on a Four Corner Debate visit this website http://www.educationworld.com/a_lesson/03/lp304-04.shtml). The objective of the debate activity was for students to consider issues of privacy and ethics as they relate to data collection and statistical analysis. Sometimes it is helpful for students to see other sides of an issue by not getting to pick the point of the view they are arguing. So each student was told that in a few days a statement was going to be posted to the discussion

board that they would need to debate and that they had to pick their point of view before the statement was posted. The students had to pick if they "strongly agreed", "somewhat agreed", "somewhat disagreed" or "strongly disagreed" with the statement. Several days later the statement "Data can only do good things in today's world," was posted. The students then had to support their point of view with respect to this statement.

The fourth activity asked the students to complete a collaborative quiz on four questions with multiple parts about the sampling distribution of the sample proportion and the sample mean. The students were first asked to complete the assignment on their own and post their answers and then to work together as a group to complete a response from the whole group. This idea of the use of a collaborative online quiz came from Audbjorg Bjornsdottir and Ellen Gundlach who also presented at USCOTS 2011. Only the final quiz responses from the entire group were graded and participation in building the team's response to the assignment was a part of the grade. The last assignment was for the students to critique other students' semester project.

The instructor found grading the discussion board very time consuming for 67 students. It was important to the instructor and to the students that every post be read and for each assignment to be commented upon. In particular, grading the second assignment was exceptionally time consuming and using this assignment with more students would be unreasonable. The students also resisted the group components of the activities. They were uncomfortable coordinating group activities with other students not in the same town and became very frustrated with students that did not respond in a timely manner. Additionally, for the fourth assignment there was very little discussion over the quiz answers. Students did not want to point out that another student was wrong in this environment. The instructor expected the students to have worked together more to make sure that all of the answers submitted were correct. In the future, the instructor plans to have the students submit a group contract laying out each student's responsibilities to help students feel more comfortable with the group assignment.

The discussion board and chat room in Sakai, Elluminate software and email were all used to improve interaction in the online course and to help build a sense of community. Email was the preferred method of communication by the students with the instructor. This was confirmed from the post class survey in which 22 responded, where 88% said that email with the instructor was "very important".

How will high stakes assessments be administered in the course? How do you handle formalized assessment exams in an online environment? How do you test the student's understanding of the material when you are not physically in the same location? How do you ensure the integrity of the exam? An online test proctoring service, ProctorU, will be discussed as well as suggestions for a positive proctored exam experience for the teacher and student.

Determining how to set up high stakes testing in an online environment can be very difficult. The instructor needs to think about what type of assessments work the best at determining how well the students have learned the material, what type of mechanisms need to be in place to ensure that the students are who they say they are and be sure that the security and integrity of the exam itself remains protected.

For this course, the instructor determined that the best way to conduct high stakes testing was with an online proctored multiple choice test. Some schools require students in an

online class to meet on campus for testing. The author's university gave specific requirements that the course had to be completely online including assessments so the instructor determined that using our course management system to deliver multiple choice tests was the option that would work the best under the constraints. How then could you make sure that the questions on the test remained secure? To do this, the instructor determined a short time frame for the students to take the test. All students had to begin their exam within three hours of the first exam being started. The ordering of the questions and the answers were randomized for each student. The students would also be allowed a digital formula sheet that the instructor provided. Additionally, makeup exams had a completely different set of questions from the main exam. The students were also directly proctored during the exam by an online test proctoring company called ProctorU. The student initially had to register with ProctorU before the exam date and pick a time within the three hour window to take the exam. The actual cost of the proctored exam was covered in the course fees but if the students registered with ProctorU late on the day of the exam they had to pay an additional small penalty fee. Before the exam, the students were also encouraged to perform a system check of their computer to make that sure that it would fully function with ProctorU's monitoring software. On the night of the exam, the students logged in to the ProctorU software and were greeted by a proctor in a video chat using a webcam. The students would then allow the proctor to see their computer screen so that whatever is on the computer screen is viewed by the both the student and proctor as well. The proctor then asked to see the student's ID card and asked a few questions to ensure their identity. The company also took a picture of the student that could be used for later reference if needed.

From an instructor's point of view, setting up the exam time with ProctorU was very easy. The company requires that the instructor complete a short Excel spreadsheet that includes start and stop time of the exam, exam length, the date of the exam, the password of the exam, and if any special accommodations were needed. The instructor then sets up the exam within the course management system and sets a password for the exam. The proctor at ProctorU inputs the password allowing the student to only then proceed to take the exam.

There were two tests conducted this way for this course. For the first exam, there were only two students who had trouble completing the exam at the scheduled time; however, these issues had nothing to do with the proctoring company. For the second exam, there were multiple problems during the testing period. The first problem was that the test did not release in the course management system due to a problem within Sakai. After the test was forced to release, the new password had to be sent to the proctoring company. The new password was sent by email and called into the testing center on the East Coast of the United States. Unfortunately, the proctoring company did not relay that password on to their second testing site on the West Coast (who handled the later night exam start times), so more students were delayed while the instructor had to email and call in the new password again. Additionally, the proctoring company did not update their internal record about the availability of the electronic formula sheet to the students during the exam. So, an additional phone call and email had to be made to the proctoring company to fix the problem. In short, the first exam went very well, but the second exam had multiple technological and communication issues with ProctorU after an initial issue in Sakai delayed the exams release. For future semesters, ProctorU has been given multiple contacts for the instructor to enable quick resolution of any future problems.

What additional requirements might an instructor need to run an online course? For course creation the instructor required several pieces of hardware, including a microphone, webcam and a laptop tablet PC with a highly accurate Wacom stylus pen. The laptop was a Fujitsu Lifebook T5010 series running Windows Vista with 4GB of memory. A large amount of memory and a fast processor were needed due to the high degree of recorded graphics in order for one of the programs used for recording the course (Microsoft OneNote discussed below) to run smoothly.

For this course, the student needed a copy of the textbook and a copy of the course workbook containing a basic shell of the course notes. The workbook is a 120 page document with the examples, exercises, terms and important concepts for the course; however, the examples and exercises are not completed. The students completed these examples and exercises with the instructor while they watched the video tutorials as the instructor proceeded through the notes. This allowed for the students to concentrate on statistical understanding, rather than copying basic notes.

Microsoft OneNote for the tablet PC has some very powerful capabilities. The program allows a user to include handwritten notes in a file by using a stylus. So, instead of working out a problem on a chalkboard, the instructor could work out the problems on the screen in OneNote. The instructor could write directly on the screen using the stylus and write words, draw pictures or shade in graphics. The stylus on the Fujitsu tablet was very easy to use and worked essentially as a real ink pen. In OneNote, the color of the pen and width of the pen could be easily changed during the course of the lecture. Unlike in some other programs that shade entire screens unless used in a completely enclosed area, the pen would only shade in areas that it was directed to shade even if the area had an opening in the "box". For example, this intelligent shading is very important when shading the area under a Normal Curve. OneNote can also insert other document types such as Word files or PDF's into the program and write directly on those documents. The shell of the notes from the workbook that the students had was therefore imported into OneNote and then the instructor recorded video tutorials of the discussion and completion of the notes by writing on the screen of the tablet PC. Microsoft OneNote was chosen rather than Microsoft Powerpoint because it allowed for a less restricted working space and allowed the instructor to work out the problem more similarly to how it would be done on a blackboard or on a sheet of paper. One of the benefits of this setup is that video tutorials could be easily and quickly recorded. Several times during the semester additional video tutorials were recorded based on student requests. Additionally, OneNote allows the final set of notes to be exported as a single static file rather than an active video if the instructor desires. Figure 4 shows a screenshot of OneNote.

For sound used in the video tutorials, four sets of microphones were tested: the microphone built into the tablet PC laptop, an Azden WLX-PRO VHF Wireless Microphone, a Samson SWAM2SES N6 Airline Micro Wireless Earset, and an H530 Logitech Headset Microphone. Two things should be considered when evaluating a microphone for online course use: the sound quality of the recording and the ease of use. All of the microphones except for the Samson microphone had poor sound quality in the instructor's opinion. The other microphones would either pick up the breathing of the instructor and/or ambient room noise such as the slight movement of paper on the desk causing distracting noises on the recording. The laptop microphone was the easiest of the four to use, but the poor sound quality made it a poor choice. The Samson microphone took a few more steps to get working; however the steps required were minimal. The

Samson microphone did not pick up the breathing of the instructor and filtered out surrounding area noise making it the best option of the four. The Logitech microphone is much cheaper and is an acceptable second choice if the budget is limited.
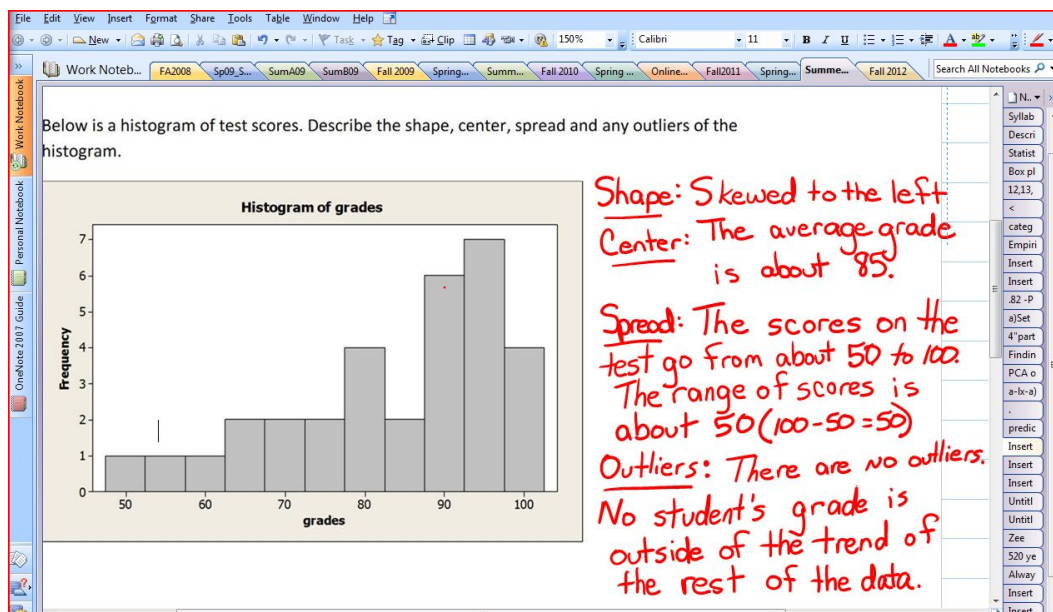

Figure 4. Screenshot of OneNote

Table 5. Breakdown of microphones tested.

Type	Ease of Use	Quality of Sound
Microphone on laptop	Very Easy	Picked up ambient room noise
Azden	Easy	Poor
Samson	Moderate	Clear, no ambient noise
Logitech	Easy, but the instructor was connected to the machine by a cable.	Picked up breathing of the instructor

4. CONCLUSIONS AND RECOMMENDATIONS

For conclusions, the specific course assessment will be given as well as a set of recommendations for teachers teaching an online course for the first time.

4.1 Course Evaluation

The overall course rating given by the students in course evaluations was 4.42 out of 5. Table 7 shows the final grade distribution for this course and for another offering of the same course without the use of the technology discussed in this paper. The other course was a hybrid version with online lectures but required attendance in lab. Grades are fairly similar between the hybrid and completely online versions of the course.

Table 7. Grade Distribution for the Course

Grade	A	A-	B+	B	B-	C+	C	D	E (failure)
Students in this course	31%	8%	15%	16%	6%	6%	10%	3%	5%
Students in hybrid	29%	7%	18%	16%	4%	10%	13%	1%	2%

4.2 Overall Assessment of Technology

1) SoftChalk was an easy program to learn for lesson building for someone without a strong website HTML programming background. The program worked well at presenting formulas and graphs, which is very important for an introductory statistics course, and made lesson website creation very easy. Additionally, the ability to add quizzes and other activities helped improve the learning experience.
2) The tablet PC was a good tool allowing for quick graphics to be drawn for illustrating statistical concepts.
3) Camtasia Relay recordings with the use of the tablet PC were easy to make and allowed for quick explanations of material to be presented to students.
4) StatCrunch allowed for the students to collect and investigate their own data as encouraged by the GAISE guidelines.
5) SoftChalk Lessons and MyStatLab allowed for immediate feedback while students were practicing working with statistical concepts.

4.3 Recommendations for Instructors of Online Introductory Statistics Courses

Do not assume that students will pick up different software quickly. Introductions to all forms of software used in the course should be provided to make the students more comfortable with the environment.

1) Encourage communication through email and chat rooms. Students should be encouraged to send email for questions, since this is still their most comfortable form of communication. Also, students preferred the chat room in Sakai that was much simpler to use and more similar to the text function on their cell phone rather than Elluminate's more complex chat room.
2) Software for a course should be chosen to enhance a course and should take a back stage to the course material. Elluminate's complex interface was cumbersome to use, a that fact kept it from being used more frequently. In contrast, the SoftChalk lessons, Camtasia Relay videos, MyStatLab, Jing!, StatCrunch software and online statistical applets added to the learning experience. The programs were easy to use, worked seamlessly in the background and aided in the learning of the material.
3) More interference from the instructor to stimulate discussion and team work should be made. The discussion board assignments did not generate the sense of community that was their primary goal. Additionally, the instructor should not

assume that students will be completely comfortable in an online discussion board even though they may be digital "natives" and have grown up with email and the internet. As a result, the students did not work together well to make sure that the work submitted was correct.

4) Always be online for support during proctored exams. The online proctoring worked, but there were some rough spots. Extra effort should be made to communicate with ProctorU and the instructor should always be available through email during the exam to fix any problems that may arise.

5. FUTURE RESEARCH

The next step in this research is to see what type of improvements to small group assignments in an online course are the most effective. What methods result in a larger sense of community, greater self-efficacy and higher test scores? What type of team building works well in this environment? Additionally, what other technological options should be investigated as outlets for interaction beyond the discussion board in the course management system? Perhaps wikis, Facebook or Google+ Chat rooms, for example, should be used. Should assignments be synchronous modes of interaction (planned "chat room sessions" or "planned group activities") rather than asynchronous discussion board assignments? Another possibility would be to look at creating a course from completely open software for an institution or country with limited resources.

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