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Introduction

During the last two years of my undergraduate education I knew I would want to go onto graduate school to continue my education. In order to fund graduate school I needed a way to stand out from the rest of the other applicants who also need financial aid. I decided the best way to do this was spend my senior project researching recommendations for how to teach a statistics course. This would make me stand out from the other applicants in that I have knowledge of current guidelines for how to teach an introductory statistics course. To accomplish this, I read articles on teaching, enrolled in an online teaching course at the University of Minnesota, took a teaching seminar offered at Cal Poly, and created surveys to get an idea of what current introductory statistics students think of statistics and the various teaching methods used by professors. The goal of this project was to give me an idea of what to do and what not to do while teaching a course and to help overcome the anxiety of teaching a course. As a deliverable of this project I have a list of what to do and what not to do that could be used by me or any other students who may be required to teach a statistics course.

Overview of what I did for my Senior Project

My entire project was focused on teaching. My goal was to collect ideas and examples that would help me become an effective teacher while in graduate school. To start my project, I began reading articles about teaching in graduate school and different recommendations on how to teach. During this time I formulated ideas on how to continue learning about proper teaching methods. As time went on I began to take part in lab surveys that were given to some of the Stat 217 classes. These surveys aimed at finding students’ opinions of the in class labs. The goal was to see if these labs were effective in educating students. I spent a lot of time entering the lab data into various excel documents. Since this was not the major focus of my senior project I only wrote a small section about the findings. I also recorded test and quiz responses of the Stat 217 students. These results never show up in the report because I was not attracted to the analysis of this data. I gave some advice for a survey given to the Stat 217 students about the technology used in the labs. I used these responses to get a feel for how the students like the use of technology in the classroom. The Stat 217 surveys gave me the idea to survey other introductory statistics courses. I decided to survey the Stat 130 students because the class content is slightly little different than Stat 217 and was being taught in a novel way, Winter 2011. Stat 130 does not have as many equations and testing methods as Stat 217. In surveying Stat 130 I hoped to get a good idea of students’ initial feelings of statistics and their feelings about statistics after the course. Before I wrote this survey I read a couple articles on how to develop a survey. The articles focused on surveying statistics courses and other math courses. Along with the Stat 130 survey I decided I wanted to survey the Stat 150 students to get an idea of what they think about statistics. I also wanted to see what they thought about the Statistics Department and Stats Club. I was curious what their opinions were because I never see them in the halls and they never show up to club events. Mid way between my survey designs I was advised to enroll in an online teaching course at the University of Minnesota. This class consisted of reading articles and participating in online discussions. This class was the bulk of my project and exposed me to most of the ideas and methods for teaching statistics. The course really taught me how to be an effective teacher. Then I decided it would be interesting to survey high school students taking statistics. I originally planned to administer surveys before and after the AP
test but due to complications at the high school this did not happen. I wrote my survey with intending to find out what students thought about statistics and why they planned or did not plan to take the AP statistics test. Finally I decided to enroll in the Stat 400, the teaching seminar offered at Cal Poly. I did this to get different ideas about teaching statistics and see what other students thought. I also wanted to compare this class to the online course I took. Overall, my project was a great way to expose myself to teaching statistics and gave me many ideas on how to effectively teach a class. The one thing I didn’t get out of the project was actual practice teaching a lecture.

**Becoming a Teacher of Statistics Online Course**

As part of my senior project I participated in an online course titled *Becoming a Teacher of Statistics* taught by Michelle Everson at the University of Minnesota. The goal of the course was to prepare excellent teachers of statistics who will make statistics a positive and successful learning experience for students. In order to do this the course covered current recommendations for teaching introductory statistics, discussed first statistics courses, talked about how to properly use technology in the classroom, went over ways to assess students’ learning, and surveyed various activities that can be done in a classroom. The students in the course were required to read articles weekly and participate in an online discussion. Since I have never had any training in how to teach a class I knew this course would give me an outline of what to do and what not to do while teaching an introductory stats course. Most of the students in the course were current teachers or had taught a course in the past which was very helpful during the discussions because they were able to discuss what worked and what didn’t from their teaching experiences. To outline what I learned from the course I will discuss the major topics that were covered and share what I think would be good practice when teaching a stats course. The ideas from each section are a collection of ideas from the readings, student discussions, and the professors follow up thoughts. To give credit to these sources I listed all the articles I read in the references section and the names of the students in the course.

The first major section was about statistics education and why a course in statistics education is important. A course in teaching statistics is useful because some argue that recommendations for teaching statistics change as technology advances so professors need to update their teaching methods. In teaching statistics it is important to get students motivated to learn statistics. In order to do this, students must see the relevance of what they are learning. They must be able to connect their knowledge to the world around them and the studies in their major. Since some students view statistics as another math course, it must be clear that statistics is much more than computations and very different from a math course. Some argue that statistics has more interpretation and context than a mathematics course, and students need to realize that there is not always a definitive answer in statistics. Getting students to grasp the idea that nothing is 100% certain in statistics can be a difficult area to teach. From the articles that went along with this section of the course, the authors suggested what needs to change from a “traditional” statistics course and a “modern” statistics course. A “traditional” statistics course is one with a lecture and problem sets, a “modern” statistics course is one with hands on activities and the use of technology. The authors of various articles suggest that statistics courses need to focus more on data and concepts rather than formulas and calculations. Courses also
need to emphasize statistical thinking and use active learning. One of the major reasons why a “modern” statistics course is better is due to the advances of technology and the ability to have computers do most of the tedious calculations and produce graphics. Another recommendation for teaching a statistics course comes from the GAISE report. This report consists of six recommendations for teaching statistics at the college level. They are: emphasize statistical literacy and develop statistical thinking, use real data, stress understanding rather than knowledge of procedures, integrate active learning into a course, use technology, and utilize appropriate student assessment. In the next paragraph I will share a few of my ideas and suggestions on how to teach a course based on everything just listed.

In teaching a course it is crucial to get students motivated. A professor can accomplish this by finding relevant data that students will enjoy. This can be done on the first day of class with some kind of meet and greet activity. An activity like this can be used to collect data on the students to be used later in the course and find out what interests them. With this data, a professor can also explain basic topics and jargon such as variables, samples, populations, variability between samples, and data summaries using graphics and numerical summaries, using the contexts of interest. This initial activity will give students an idea of what statistics is, show them that it is not all calculations, and get them thinking statistically. An activity like this incorporates active learning if the professor lets the students come up with questions and explore different graphical and numerical summaries, the activity can also incorporate technology in the analysis of this data.

The next major topic stressed using real data in a classroom. Real data is important because it allows students to explore and come up with their own ideas of what the data might show. If the data context is relevant it will motivate students much more than made up data or data that is outdated. Real data can also show students to how messy data in the real world can be. Real data will also expose students to data cleaning and management practices. Exploratory analysis is another good topic to teach that comes from using real data. Students need to get used to plotting and graphing data before they run tests. They need to get a visual idea of what is going on, look for patterns, and come up with their own ideas about the data before they run any hypothesis tests on the data. These activities will get student more involved in the data and more excited to test the data and see if what they hypothesize is correct.

In my course I would make sure to have data relevant to students. I would survey the students on the first day to get data about them and get an idea of what interests them then I would spend time finding data sets. I would try to find a few data sets to use throughout the course, not just one or two like some professors do. To get students active with the data I would make sure the data needed some recoding and organization. I would keep it simple to not draw to much attention to the cleaning phase. I would also have students explore each data set and come up with descriptive statistics, graphs, and ideas of what is going on with the data and why. I would also have them focus on relating their observations to the particular context.

Another topic covered was stressing conceptual understanding and statistical reasoning. GAISE recommendation stress that students should understand concepts rather than procedures. Professors
need to focus more on the underlying idea and stay away from formulas. Focusing on formulas and procedures may lead to students focusing on how to do something rather than why. This may be difficult to teach because some students may enter the class thinking they will just be learning procedures and calculations instead of thinking beyond the mathematical calculations. Some say it is harder to teach concepts and ideas than teaching formulas and procedures. Teachers also need to get students thinking statistically and have them make sense of the statistics they are presented with. Technology can be used to perform calculations and create visuals of concepts. A professor can also achieve conceptual understanding and statistical reasoning through a lecture based on the Statistical Reasoning Learning Environment (SRLE). This type of lecture consists of hands on learning with the use of real data; students are supposed to explain how they came to their answer and work on problem sets before class and discuss areas of difficulty during lecture. The professor is supposed to question students rather than lecture and get students to discuss their ideas and relate back to previous topics. This method of teaching can be difficult because it is not easy to anticipate how things will go in a class session like this. With a typical lecture based class session, a professor will know exactly what to cover and have an idea of the questions that could arise. It is also difficult to have the SRLE type of lecture in a larger classroom.

Personally I am not a fan of the SRLE teaching method. I do not like how the learning is mainly through questions and having students figure everything out. The students are required to read everything before the class and reinforce their learning through questions and discussions. I feel this would frustrate some students and make them want to give up. The only suggestions from the SRLE lecture I would use are having students relate to previous material and have students come up with their own ideas about the data. To focus on concepts rather than computations, I would introduce basic formulas but show the students that everything can be done on a computer or calculator. I would then focus on why we use a specific method and what it does.

Statistical literacy and statistical thinking are more important topics in teaching statistics. Statistical literacy is the understanding of basic language and methods of statistics. One aspect of statistical thinking is a way of thinking that uses logic and reason of statistical tests to find a problem and come up with a solution. It also includes understanding the different statistical tests and their uses, as well as knowing when to select the proper test to answer a specific question. Students need to be able to understand statistics and all of the definitions and terms. Students need to be both statistically literate and able to think statistically so they can properly interpret and critique statistical findings. Statistical literacy allows students to see terms and understand what they mean. For example if they are reading a news article and terms like “odds ratio” or “confidence interval” are used, a student in a statistics course and after the course should be able to understand what these values mean. Students need to be able to think statistically so they can decide what test to use or understand why a specific test was used when trying to test a research question. Students need to also be able to understand why specific methods are used when they are presented in an article. To get students to become statistically literate and able to think statistically, professors can have their students read articles on studies using statistics and interpret what the article is saying.
In a course of mine I would have students read a news or journal article that contains statistics and explain what the statistics in the article mean and why the tests listed in the article were chosen for the presented analysis. I would also have them evaluate the testing method if it is in the scope of the class. In addition I would have the students try to find a video clip of a news station reporting statistics and interpret what they presented on the air. I feel this activity would get students exposure to statistics in media and think about how the statistics are being used. I may also have the students take vocabulary quizzes to develop their knowledge of all the terms in statistics.

The next topic was active learning in the classroom. Active learning is essentially hands-on learning, students get to explore data and come up with their own ideas, construct their own knowledge. Active learning allows students to actively engage in the classroom and with classmates; this type of learning can be fun for students and make them more motivated because they are actively participating. This learning style also accounts for those who don’t learn as well from pure lecture, and lets students learn from each other and their own exploration of data. Active learning can be difficult for a professor because they have to come up with useful activities that will actually promote learning of a specific topic. Professors need to figure out what topics to use active learning with, come up with a balance between active learning and lecture, and be able to manage time in classroom because activities can sometimes take up most of the lecture period. These group activities can be difficult due to time constraints of one class period, how to form groups, and much preparation is needed. A major problem with active learning is not being able to anticipate what will happen during the activity. There could be problems with the technology or students may spend more time on the activity than anticipated. A good active learning activity needs to be relevant, fun, and have a point to it or else students will think of the activity as busy work. Activities should also be well structured and not too long so that there will be time at the end for questions and a discussion. The activity should promote classroom dialogue and working in teams. While an activity is going on the professor should be walking around answering questions and asking questions to the students to check their understanding. Active learning should also encourage students to make their own predictions, use technology, work with others to test research questions, explain their findings to the professor and others, and be fun and motivating for the students. After an activity a professor should follow up with quick feedback and have some kind of assessment relating to the activity. Professors should keep in mind that activities can be a great learning tool and not to underestimate them.

While teaching a course I would make sure to have activities at least once a week. I would have students do some kind of worksheet in a computer lab to get used to working with technology and exploring data. I would have some of the labs be in groups and some as individual work. I would want the labs to summarize the week’s topics and be interesting to the students. In the worksheets I would have questions for the students on what they think will happen with the specific data and what actually happened. I would also have them explain why something happened with the data or what specific results were obtained. I feel this would get students actively participating in statistics and investigation of statistics. Finally I would wrap up a lab with the correct answers to the questions but first get some student input.
Another section was on using technology in an introductory statistics course. Technology is very useful because it can automate calculations and allow students to focus more on why a result is obtained and what it means. Technology also allows students to explore data more through manipulation and simulation, students can ask “what if” questions about the data and use technology to find an answer quickly. Another advantage is the ability to check hand computations and provide hands on learning. Before using technology professors need to come up with ideas on how they will use it for various parts of their class and what it will add to the course. When selecting a type of technology professors have many different things to consider when selecting the right software. Professors need to consider the cost to students (some packages can be quite pricey), and students will need easy access to the technology, it would be best if students could download the software for free on their own computers or easily find a computer lab with the software. Professors also need to figure out how often they plan on using the technology and if students will be required to use it outside of class, and there needs to be a backup plan if the technology fails. A major thing professors need to consider is how user friendly is the technology, students should easily be able to understand the software, and the professor needs to not waste time always showing students what to do, they need to have as much time as possible to play with the software themselves.

From the articles I read and the discussions I was part of I would ideally like a software package that could be downloaded onto students’ computers and would be free for students. I would also like a menu driven program because it would be the easiest for students to understand and easy to teach. I would have students use the technology during a lab and outside of class for homework. Ideally I would like to have a part of my exams include technology.

The final section was on assessment. Assessment can consist of homework, quizzes, exams, projects, lab work, and anything else that demonstrates a student’s ability to do and explain statistics. For exams a professor needs to think carefully about how they word their exam questions and how they might challenge students. The questions need to be clear so students do not get confused. Stay away from multiple choice questions because they do not allow students to express why they chose a particular answer. Without explanation a professor won’t really know how a student is thinking and how they approach the material. An exam should focus on conceptual understanding rather than just computation and memorization. This can be done by having students explain how they came to their answers. Professors should also think about how to prepare students for an exam. A professor needs to decide if they will set aside time for a review session, make an outline for the students, or provide review questions. This depends on how much time and effort a professor wants to put into helping the students prepare for a test. A decision also needs to be made if students can use a note sheet on the exams, if they are open book, and if there is a take home part. After an exam professor feedback is important to learning. Feedback helps students realize where they went wrong and what they need to do to fix their mistakes. The sooner the feedback is given the better because after a while students may forget what they wrote down and why. Professors can also spend time going over an exam in class and allowing time for questions and explaining commonly missed problems. Professors can also allow students to get back points on their exams by correcting their mistakes before a professor provides feedback and the solutions. Another form of assessment can be projects. Projects allow students to
apply what they have learned to the real world and explore topics that interest them. Projects can be individual or require groups. They can also include an oral presentation. Groups simulate the working world and presentations give students practice discussing statistics to others. Teachers need to keep in mind how much credit they plan to give for the projects, how large the projects should be, and the material that should be on a project. Projects need to have specific goals so students have some sort of direction. They also need a length minimum and maximum so students know what to shoot for. Finally, projects should be fun for students so that they are motivated to do well on them and learn from them.

In my course I would definitely include a project. I personally loved working on projects because they allowed me to pick my own topic and combine everything I learned from the course. I would allow students to work in groups to combine different ideas and interests. Ideally I would like to have presentations so others could learn about the other applications of statistics in different fields but that would depend on the class size. As for quizzes and exams I would try a mixture of questions. I would have some multiple choice questions on basic definitions and concepts, some computational questions, and some questions explaining the major ideas. I would possibly allow the students to fix mistakes on their exams before I gave them feedback. I feel this is a useful learning tool because it makes them realize what they are doing wrong and how to fix it. After the revisions were turned in I would provide feedback if there were still errors on the exams.

The online course, *Becoming a Teacher of Statistics*, was a great introduction to learning how to teach a course. It covered all the major topics in teaching a class and how to properly do it. The course covered topics in difficulties in teaching statistics, using real data in a classroom, statistical reasoning, statistical thinking, active learning, using technology, and assessment. I learned a lot from the course but the best way to learn about teaching is to develop and teach a lecture for myself. In the next section I will discuss a class at Cal Poly that was focused on teaching statistics.

**Teaching Statistics Course at Cal Poly**

Along with the online teaching course at The University of Minnesota, I took a teaching course at Cal Poly. This course was not as in depth as the online course and meetings were in person rather than online like the University of Minnesota course. The course was titled *teaching Statistics* and taught by Allan Rossman, Beth Chance, and Soma Roy. The course covered many of the same topics as the online course discussed earlier, so in this section I will talk about some of the opinions the students in the course had. Finally I will compare the two courses in terms of the learning environment, online versus in class.

Many ideas were presented in the discussion of teaching statistics versus mathematics. The majority of the class agreed that teaching statistics is more difficult than mathematics because there are no definitive answers to statistics like there are in mathematics. This can be difficult for students to overcome. Many come into a statistics course thinking it will be like a math course with many equations and one right answer. The class also agreed that statistics can be difficult to teach because all answers in statistics require context and it can be difficult for a professor to come up large volumes of practice questions. A professor has to make it clear to the students the first day of class that statistics is not like
every other math course. It is not a course of formulas and plugging in values. It is a class that requires
context and looking at the unknown. Teachers must stress that statistics requires context while math
doesn’t always require this. Professors can show an example of this to students by presenting a dot plot
or scatter plot with no context and have the students hypothesize what is going on with the data. As this
goes on the professor can slowly add in context such as units then explain the sample that the data was
collected from.

Working in groups was another major topic during the discussions. The class agreed that group
work is important in a statistics course. In the working world statisticians usually work with people in
other fields. In a course a professor should let students work together to build up their communication
skills and ability to explain statistics to others. Group work is also a great way for students to learn from
each other and learn by teaching others. The one problem with group work is the free riders. To get
around the problem of free riders we discussed cooperative learning. Cooperative learning requires
working with others but the members in the group have to make sure everyone understands the
material. A professor could evaluate the group as a whole or use one person to represent the group.
This forces everyone in the group to be responsible for all of the topics. The major problem with this
kind of group work is how the groups are evaluated fairly on their collaborated work. Should one person
in the group be chosen at random to represent the group, should all of the students’ scores be averaged
to make a group grade, or have all members get individual grades? The class thought that one student
being responsible for the group might be a little unfair. If a weaker student is chosen or one who is not
motivated to learn the material, a poor grade could drag the grades down of the students who excel and
work had in the course. Averaging the grades is a little better but still puts some of one’s grade in the
hands of others. Individual grades take away from the idea of cooperative learning because then it really
doesn’t matter if everyone in the group understands the material. In my opinion taking the average or
median grade is the best. It forces everyone to understand the material, as an incentive for students to
do well they could add extra credit if the entire group gets over a specific percent. Or the professor
could provide a group 5 minutes to check each other’s answers before an assignment is due. Overall
cooperative learning is a great idea, it is just difficult to find a fair grading system.

The final major topic was on student assessment. Teacher feedback was a major topic in
assessment. The majority thought a professor need to provide feedback as soon as possible before a
student forgets about the assignment and why they wrote down specific answers. It is also important to
get students to look over their assignments. Most of us agreed that students will get an assignment back
and stuff it in their note book to look at later. Most of the time a student forgets to look at it or never
finds the time. A professor should allow students roughly five minutes in class to look over assignments
so they actually read the comments. We also felt that there needs to be a grade attached to something
that a professor provided feedback on. Without a grade students will most likely not read the
comments. We also discussed multiple choice questions on a test. They are great for large classes but
frustrate students because they can’t explain their reasoning and do not allow for partial credit. One
idea was to have students explain their reasoning to the response they select in a multiple choice test.
This would allow professors to still grade tests quickly. They could just look at the ones the students got
wrong on a scantron and look at their explanation on the test paper. One of the professors brought up
the idea having multiple choice questions then multiple choice reasoning to the answers. The class immediately showed dislike to this idea. Students tend to second themselves on multiple tests and this would make a test even more stressful. If a class is large the multiple choice with written explanation is probably the best testing method, otherwise stick with short answer questions.

Online course and in class courses have their pros and cons. It is hard to determine which is better. An online course allows students to reply to discussion topics at a time that is convenient for them. The can respond during the middle of the day or at midnight, while an in class course requires students to show up at specific meeting times throughout the week. Online classes can also force everyone to give input on a discussion topic and they allow the shy students to respond without having to be afraid of speaking in front of others. In class discussions might not give shy students a chance to voice their opinions. Online courses also allow students more time to generate and gather their thoughts. In class courses require students to think on the spot which may be difficult for some. Online classes lack the ability to see others body motions during a discussion. The absence of body motion may take away the emphasis a speaker might have on a particular topic. In class discussion also allow for a more lively discussion. An online course has a lot of down time; it can take a while for others to respond to a post of other student’s comments. Overall I like how online courses force everyone to voice their opinions and I like how in class courses allow for lively face to face discussions.

Additional Readings

Along with all of the readings done in the online and in class teaching courses, I read a few more articles on teaching. The articles went over many of the same topics covered in the teaching courses. They also talked about being a student teacher in graduate school and gave tips on how to succeed. Like the other readings these readings suggested that an introductory statistics course emphasizes statistical literacy, use real data and technology, include active learning, and use assessment to improve learning. For a graduate student teacher, statistical literacy can be taught by including statistical articles and focusing on understanding of procedures rather than ability to do them. Data sets can be collected from other professors or online. Active learning can be achieved through some sort of group work or projects. Finally, assessment is most effective if returned in a timely manner and with personalized comments. To relieve the anxiety of teaching it is beneficial if graduate students take some sort of teaching course. These courses expose them to teaching methods and possible hard ships while teaching. Graduate teachers are also encouraged to discuss ideas with other grad teachers in the discipline. Sharing ideas with each other will help establish what works well and what doesn’t while teaching. Working with other grad teachers can also create uniformity between the different courses taught by graduate students. Sharing ideas with each other can also lead to a more efficient instructor. Grad teachers can work together to come up with lecture notes, design homework assignments, and even write tests. This will allow teachers more time to think about how they will present the material or anticipate questions. Finally, being a graduate student teacher will improve a student’s ability to communicate statistical ideas and will be useful when they go out and find a job. The best way to prepare for teaching is to take a class and share ideas with other student teachers.
Stat 130 Survey

Statistics 130, Introduction to Statistical Reasoning, is an introductory statistics course for most non-technical majors: journalism, some agriculture majors, and liberal studies. The course covers more statistical ideas rather than performing statistical tests. The course catalogue description is,

**STAT 130 Introduction to Statistical Reasoning (4 units)**

Survey of statistical ideas and philosophy. Emphasis on concepts rather than in-depth coverage of statistical methods. Topics include sampling, experimentation, data exploration, chance phenomena, and methods of statistical inference. Credit not allowed for students with a previous statistics course. 4 lectures. Prerequisite: Satisfactory completion of ELM requirement.

I was able to survey this class before the quarter started and after the quarter was over. The initial survey is survey 1 in the appendix and the follow up is survey 2 in the appendix. In my surveys I wanted to get an idea of what students thought about statistics before and after the class. In particular I tried to get an idea of how useful they think statistics are. I also wanted to look at different teaching techniques used in the course. The class had roughly 70 students but the follow up survey had a much smaller response rate than the initial. The initial survey had 53 respondents while the follow up one had 37. I had asked for the last four digits of the students cell number to track their before and after responses and 36 students had taken both surveys. With these poor response rates I am only going to look at students who answered both the initial and follow up survey.

I wanted to find out what students thought about statistics before and after the course. In particular I wanted to see if they were excited to take the course and how their excitement changed after the course was over. Since most students think statistics is another math course I wanted to get an idea of how much math they thought there would be in a stats course. Before the class students were pretty neutral about the class being heavily math based. Before the class their opinion shifted towards the “disagree” side. The students must have realized that there is more writing in an intro stats course than there is math. It is crucial that at the beginning of an intro stats course they professor makes to clear that statistics is not like every other math course. Statistics requires much more writing and all answers have to be in context.
I also wanted to find out how useful students thought statistics are before and after the course. I expected there to be a large positive shift after the course was over. Figure 2 has a graph of how useful students think statistics are in their major and another graph for everyday life. After looking at the before and after graphs my original hypothesis seemed to be invalid. It appears that after the course students thought statistics were not as useful as originally thought. Most students thought statistics were more useful in everyday life than in their major. It is very interesting to see a shift like this, it was completely unexpected. It would be interesting to further investigate this and find out why students feel this way.
In addition, I wanted to get some ideas of how the students like the different teaching methods used in the course. Figure 3 displays the results. I asked questions about using lecture notes with fill in sections, having the students do projects, suggested exercises rather than mandatory ones, and reading the text book. The class used lecture notes provided by the instructor with fill in sections. As the lecture went on student were supposed to fill in the areas with the notes the professor wrote on the board. These kinds of notes give the students better direction in what to write down and helps show what is important. The one negative thing about these notes is some students may just mindlessly copy down what a professor is writing on the board in the proper sections. I asked a question about how easy it was for the students to lose focus with these kinds of notes. Roughly half the respondents disagreed, however fourth strongly agreed that notes with fill in sections make it easier to lose focus. In my opinion I enjoy these notes because they give direction. With most of the students disagreeing with the question, I feel it is pretty safe to use these types of notes even though some lose focus because of them. Throughout the course the students had to work on projects. I wanted to get an idea of how much they liked them. I personally enjoy projects and feel they help bring all the different topics together and let me be creative. Two more students disagreed with the projects being helpful than agreed. This makes me wonder why they didn’t enjoy the projects and see the value in them. It could possibly be that they did not like how there were so many or that they just didn’t have time to focus on them. In a class of mine I would try to have at least one project because it allows students to be creative and investigate data of their choice. The professor assigned suggested exercises from the book but never collected them. I wanted to see if students even do the problems if they are not collected. From the results about 22% of the students did not attempt them since they were not collected. This is a much smaller percent than expected. I thought students wouldn’t find the time or have the discipline to do non graded problems. More than 61% said that they usually attempted the problems. With these results it shows that some students will still do work even if it’s not graded. This can save a lot of grading time for a professor. I am still suspicious of these results and I wouldn’t expect students to do the problems if they did not have a grade attached to them. The class also had reading quizzes. I had the initial opinion that if there were not reading quizzes the students wouldn’t read the book. 50% of the students agreed that they wouldn’t have read the book if there weren’t reading quizzes. These results show me that if you want students to read a text book there should probably be quizzes about the reading or else they won’t read the book.
In figure 4 I decided to include a graph of the students expected grades in the course. I wanted to compare these results to what the AP students thought their grades would be. The classes are relatively the same so I expected the grade distributions to be somewhat the same. There is clearly a difference. AP students think they will be getting A’s in the course while Stat 130 students think they will be getting B’s. The Stat 130 grades are much more realistic then the AP students. The high confidence of the AP students might lead to problems when they enter college. They will be shocked to see how much high school and college grading differ. The AP class should be taught more like a college course than a high school course in order to prepare students for college.

The before and after surveys of the Stat 130 students gave me many ideas on what to include in an introductory statistics course. Some students believe that fill in lecture notes makes it easy for them to lose focus. Even though some students think this, I would still use them in a course because they help show the important points in a lecture. Students were split between liking and disliking projects. It might
be due to the fact that more than one was required in the course. In a course of mine I would most likely only assign one at the end of the term to wrap everything up before the final and act as review for the final. Even though suggested problems aren’t collected most students will still do them. I would most likely have problems I assign be graded just to make sure the students actually do them. I also came to the conclusion that if you don’t assign a reading quiz, students most likely won’t read the book. I was shocked to see that student thought statistics were less useful after the course. I expected it to be the other way around. In a class of mine, I would try and find the typical majors in the course and give example of statistics in their field so they could see how useful they are. Finally, it appears that once a statistics course is over, their excitement about the course increases.

**Stat 150 Survey**

Statistics 150, Introduction to Statistical Investigation, is an introductory course for statistics majors. The course introduces students to the discipline of statistics and gives students an idea of what statisticians do. The course catalogue description is,

**STAT 150  Introduction to Statistical Investigations (4)**

*Orientation to the statistics program. Introduction to the discipline of statistics and the nature of statistical reasoning. Design of surveys and experiments, graphical and numerical summaries, statistical models, and interpretation of results. Development of discussion, writing, presentation, and evaluation skills. 4 lectures. Prerequisite: Freshman Statistics major, or permission of instructor*

When I designed the survey for this class I hoped to uncover two things: find out if students feel at home in the Statistics Department, meaning they are comfortable with the staff and other students, and compare their knowledge of statistics in the real world to the students in other statistics courses. The survey is in the appendix, Survey 3. These results will help the department and Stats Club decide if they need to get students more involved so they feel at home during their time at Cal Poly. These results will also give me an idea of how friendly students think a department and professors should be. Comparing Stat 150 to other statistics courses will let me know if there needs to be more of a focus on what statistics do in the world outside of school. Along with the survey I made, I got survey data from the Stat 150 2009 and 2010 classes. This survey focused on different way of learning in the course and what students got out of the course. I will use this survey to look at different ways to teach students.

To get an idea of how the new statistics majors feel about the department I asked questions about the students desire to meet other stats students and their involvement in the statistics club. Figure 5 includes graphs to get an idea of how interested Stat 150 students are in meeting other statistics students. There is a displaying the data of how involved students want to get in Stats Club, if they are interested in more Stats Club events, and a graph of their interest to meet the lower classmen and another for the interest in upper classmen. The questions about Stats Club give an indication that students want to get more involved in the club but care to see more events. This is an interesting result because one would think that if students would want to get more involved in a club then they would want to see more events so they could be active in the club. In preparation for issues like this I included
a question asking why students aren’t involved in Stats Club. From looking at these responses students claimed they are too busy to get involved. I would say students want to get involved in Stats Club events but they just don’t have the time to. The best thing to do would be schedule events after midterms so student are free to come and join in on the fun activities. The questions relating to getting to know other students indicate that the Stat 150 students might be more interested getting to know others in their grade or a year higher. I come to this conclusion because there is a clear spike at agree in the graph of getting to know the lower classmen compared to the other graph that looks pretty equally distributed. I would think this is due to new students wanting build friendships with other students that they will take most of their classes with.

Figure 5 Graphs of how interested Stat 150 students are in meeting other stats students

I also included questions about the faculty to get an idea if students feel at home in the Statistics Department. Figure 6 includes graphs of how the Stat 150 students feel about getting to know the faculty better, the advising they provide, and familiarity with the department. As expected most students are interested in getting to know the faculty better. This is key because they are the ones who will be writing letters of recommendation for graduate schools. Students also need to be comfortable with the faculty so they can select a senior project advisor that they are comfortable with. If students were to get to know the faculty better the department would feel even more like a family. Most of the students also find the advising provided by the department to be helpful. I suspect that the ones who responded “neutral” have never talked with a professor about planning out their possible schedule. As for being a friendly place, it is clear that students like the Stats Department. The students indicated that they are familiar with the Stats Lab but it may have been more useful to look at how often they go there. The more a student goes there the more they interact with other students and faculty in the department. Overall students feel the department is a warm environment and would like to get to know the faculty. So the department should keep doing what they currently are to get the students to feel
more at home. The faculty might want to consider attending more Shack Nights to interact with the students on a non academic basis.

Figure 6 Graphs of how Stat 150 students feel about the faculty and the Statistics Department

Next I decided to look at how much Stat 150 students think they know about statistics in the real world. Figure 7 displays graphs of how comfortable students are with the application of statistics to various fields and everyday life. Overall student appear to be very comfortable with the application of statistics because the lowest response was “agree”. Comparing the two graphs it appears that students are more comfortable with statistics in everyday life than in other fields. This is most likely due to the fact that the course requires students to read various articles with basic statistics and interpret the results. These articles cover daily topics such as sicknesses and other personal habits. Comparing how confident the Stat 130 and AP Stats students feel about their knowledge of the application of statistics to the Stat 150 students, Stat 150 students feel much more comfortable than the other students. This is expected because Stat 150 is designed to introduce students to the field of statistics, and students in Stat 150 chose to major in this subject so most likely have some prior idea of what statistics can do in the world.

Figure 7 Graphs of how much Stat 150 students feel they know about the application of statistics
To get an idea of how Stat 150 students like to learn I included questions about different learning tools. Figure 8 has a graph of how students feel about handouts and class projects. The handouts are class notes with fill in sections. Students are supposed to fill in these sections as the lecture goes on. They are different from a traditional lecture because a lecture outline is already established. From the graph it is clear that most students like the lecture notes. This is not a surprising result because these lecture notes help students get an idea of what is important and keep them focused during lecture. The second graph shows their opinions of projects. More than half of the students found projects valuable. Projects provide hands on learning and allow students to pick topics they enjoy. A few students may not like projects because they take more time than a typical homework assignment and it can be difficult working in large groups. In teaching a course it would be best to have fill in lecture notes and if reasonable assign some kind of projects.

![Figure 8 Graphs of how Stat 150 students like handouts and projects](image)

From the Stat 150 survey came up with the feeling that the Stat 150 students would like to get to know their professors more, as well as their classmates at their grade level and one higher. They would also like to get more involved in Stats Club but don’t really feel they have the time to. The best way to get the whole department as a family would be to hold more Shack Nights. Faculty and student can get together and interact in a nonacademic setting. The Stat 150 students appear to have a better idea of how statistics can be applied in the world they live in than the other introductory statistics courses. This should be the conclusion since Stat 150 is designed to do this. Finally, in a statistics course a professor should try to use fill in notes and other hand outs and include projects when possible and if appropriate.

**Stat 217 Lab Surveys**

Stat 217, Introduction to Statistical Concepts and Methods, is like Stat 130 but contains more emphasis on the different tests in statistics. Students are taught statistical ideas and how to perform various tests. Students majoring in social sciences take this course. The course catalogue description is,

**STAT 217 Introduction to Statistical Concepts and Methods (4)**

*Sampling and experimentation, descriptive statistics, confidence intervals, two-sample hypothesis tests for means and proportions, Chi-square tests, linear and multiple regression, analysis of variance.*
Substantial use of statistical software. Not open to students with credit in STAT 218 or STAT 221 or STAT 251. 4 lectures. Prerequisite: Passing score on the ELM examination, or an ELM exemption, or credit in Math 104

In the sections surveyed there was a lab almost once a week that required students to use applets and software to help them understand different topics covered in the course. After a few of the labs they filled out a survey that had questions pertaining to how useful they thought the lab was and if they enjoyed the particular lab. I will only be looking at surveys from two of the labs because the other surveys did not follow the same question format. I did not create these surveys I just helped enter the data and explored the data in areas that I thought would be useful. The data collected covers four different Stat 217 courses over two quarters. I was particularly interested in looking at how useful they found the labs and how interesting they thought they were.

First, in figure 9, I looked at how interesting students thought the labs were. I wanted to see if students actually enjoyed doing the labs. This would help me decide if I would want to include labs in a class of my own. Looking at the graph the amount of student who thought the labs were uninteresting is very minimal. At most the percentage is up to 25%-30%. Comparing the labs from the two different quarters, it looks like there is a shift of interest from fall to winter. The “interesting” bar increases by at least 15% from fall to winter for both labs. There is also a decrease in the amount of “uninterested” responses. This is most likely due to tweaking the labs after they first quarter and possibly different professors. Overall the students seem to be pretty interested in the labs. If I were to use labs like these in teaching a intro class I would try to use labs that have already been used and tested. With the labs already being tested hopefully all the kinks would be worked out and the labs would be developed to attract the students’ interests.

I also wanted to get an idea of how worthwhile the students thought the labs were. Figure 10 has a graph of what the students thought. This would again reinforce my decision in whether or not to include labs in a stats course. The graph follows a similar trend as the interest graph. Students feel the labs are more worthwhile in winter quarter than fall. This is probably again due to it being the second
time the labs are taught. It is good that hardly any students selected “not at all”, this gives professors confidence that students actually see value in the labs and don’t view them as busy work.

Finally, I decided to look at how students liked the simulation and how it added to their learning. Figure 11 displays the responses. These results will give me an idea of how useful the students think the applets and use of technology are towards their learning of the material. Yet again the graphs follow the same trend as the previous two. There were roughly 10% of the students in each lab who did not find the simulation useful. I am guessing the students who said this most likely already took a statistics course before. Even though the students don’t think it helps them, they are applying what they learned from lecture to a lab and therefore repeating the information causing it to stick better in the memory. Repetition is key to truly learning something. Overall, students seem to think simulation is useful and therefore should continue to be used in Stat 217 and possibly applied to other intro stats courses.
These labs would allow students to learn from each other and explore data using technology. The only restriction to a lab like this would be a large class size.

**Stat 217 Technology Survey**

Along with each individual Stat 217 lab survey, there was a final survey about the technology used. The survey was designed to look at how interesting students found the applets used in the labs, how user friendly the technology was, and how much they added to learning.

From these surveys I wanted to get an idea of how they aided in students learning. I decided to examine how well the labs explained abstract ideas and how well they pulled various concepts from the course together. Graphs of these results are in Figure 12. Roughly two thirds of the class agreed that the labs do in fact help students better understand the abstract ideas presented in statistics. This is a good thing to see because the technology used in these labs allows students to see randomization and simulation. Roughly two thirds of the class agreed or strongly agreed that the labs pulled concepts in the course together. This shows that students are repeating what they already learned during previous lectures. This is a good thing because ideas are learned through repetition. The one limitation in these results is students never had a class without the technology used in this course. So they may actually think the technology helped when it really might not have.

![Graphs of how Stat 217 students felt about learning using the labs](image)

**Figure 12** Graphs of how Stat 217 students felt about learning using the labs

I also decided to look at how students felt about the lab procedures. Figure 13 has graphs of how students felt about the lab instructions and how user friendly they thought the procedures were. To get an idea of how they thought about the lab instructions there was a question to see if they blindly followed the instructions or thought about them as they went through the steps of the lab. From the graph more than half answered neutral and higher. This is not a favorable outcome. It gives indication that students just followed the steps to get to an answer. They really didn’t spend much time thinking about the steps. This indicates that the labs may want to be restructured to reduce mindlessly following instructions. To do this, the amount of instruction in the lab could be reduced. Instead of having step by step instructions, overall instructions could be given. A question about working with both web pages and word files gave me an idea of how user friendly the labs were. The data was somewhat centered around neutral. Roughly ten more students disagreed with the statement than agreed. This is good because students don’t find it too difficult to constantly switch between web pages and documents.
With advancing technology this becomes less of a problem with large monitors and convenience of going from one program to another.

Figure 13 Graphs of how Stat 217 students felt about the technology used in the labs

Form the Stat 217 technology survey I got the idea that students like the labs and believe that the technology helps them learn the material. The use of technology can help students visualize ideas and bring ideas together. If I were to teach a class, I would definitely include labs because it gives hands on learning. I would watch out for making the use of technology too easy. I would want students to think about that they are doing and what values they are plugging into various boxes.

AP Statistics Survey

I chose to survey the AP Statistics students at San Luis Obispo High because I wanted to get an idea of what they think about statistics. I originally planned to administer a survey before and after the AP test but due to complications at the school this did not happen. I did survey one class earlier in the year but will not include an analysis of this data because I was unable to get a follow up survey. This survey is in the appendix, survey 4. I ended up administering one survey to all the AP Stat students roughly two weeks before the test, this is in the appendix survey 5. This was not a follow up for the first survey because I did not do any analysis with the initial survey because it was not complete. In this survey I aimed to see what they thought about the application of statistics, how prepared they felt for the College Board Statistics Test, and how they felt about different teaching methods. I would use these results to get an idea of teaching methods and what students out of high school think about statistics.

I started by looking at how difficult high school AP statistics students think statistics are and why. Figure 14 has a graph of how difficult students thought it was to select the correct testing method and if difficulty in statistics was due to no definitive answer. Only two out of 62 students selected a response below “neutral”. As expected students find it difficult to decide what test to use. It is important that students know what tests to select so professors must give students practice with this. A professor can include exercises that consist of just selecting tests from various studies and explaining why. In one of my introductory statistics courses the professor included a blank table with the types of explanatory and response variables on the axis. As the class went on we wrote in what test corresponded to each combination. This table was extremely handy when it came to selecting what test to use. More students selected “strongly disagree” and “disagree” for having difficulty with no definitive
answer than the selecting the correct method graph. There was also a larger shift to neutral. This shows that students don’t have as difficult a time with the non definitive answers in statistics. However, roughly 50% of the students feel that no definitive answers are a problem. This is one of the major problems with teaching statistics. It is difficult to get students to realize that statistics is not a standard math class. The answers in statistics are extremely educated guesses as to what is going on with data. At the beginning offer a course a professor needs to make this clear to the students.

![Graph of question about selecting the correct testing method](image1)

![Graph of question about difficulties due to no definitive answer](image2)

**Figure 14** Graphs of why statistics is difficult for AP students

Next I decided to look at some of the ways students were taught statistics. Figure 15 has a graph of how students felt about the use of technology and working in groups. Students seemed to really like working in groups, 74.2%. I assume this is due to the fact that the students are so young and would rather work with their friends than by themselves. From my experience in high school, group work was easier there than in college. There is also the possibility that I am wrong, and they learn from explaining topics to each other. Either way, they believe working in groups is helpful to their learning. The use of technology (graphing calculators) graph provides strong evidence that students like using it. Roughly fifty three percent “strongly agree” that technology helped students understand statistics. This is most likely the ability of technology to speed up calculations and allow students to focus on concepts. The high school should definitely continue to use technology in the statistics course based on the survey results and recommendations from various authors.

![Graph of question about working in groups](image3)

![Graph of question about using technology](image4)

**Figure 15** Graphs of how students felt about group work and technology

Since I asked about applying statistics to the working work and daily life in the Stat 130 and Stat 150 surveys I also wanted to include it in the AP survey. Figure 16 has a graph of what students think
they know about statistics in the real world and daily life. Most felt that they knew how statistics applied in the working world. It is a little worrisome that 10% of the students selected an option below “neutral”. The only way I could think of a student not knowing how statistics could be applied to the working world is if they didn’t show up to class or put any effort in. Statistics is nothing without context so students get exposure to statistics in the real world no matter what. A well taught course requires students to use context in their answers and has them work with real data. These few students may have just misunderstood the question. As for statistics in daily life there was a large shift to the neutral column. It could possibly be due to students not realizing that statistics play a role in essentially everything. They are present everywhere in sports, daily actions, and anything else with a numerical summary. It unfair to compare these graphs to the same questions asked by the Stat 150 students since their class focuses on statistics and how it is used. When comparing to the Stat 130 students, Stat 130 students are more confident that they know how statistics are applied to everyday life.

Along with getting an idea of what students think about statistics I wanted to get a sense of what they thought about the AP test. First off I had a question asking if they planned to take the AP test, this is in figure 17. I was shocked to see that only 16.1% or 10 out of 62 students planned to take the AP test. I figured since they were in the AP class they would take the AP test, but this was not the case. I included a few questions pertaining to the AP test and they are displayed in the next set of graphs. From the free response question asking why they didn’t take the AP test, a large number of students responded with not wanting to put in the effort to study and didn’t feel prepared. I followed this question with one asking why they chose to take AP statistics and most responded with it being easier than calculus and was the only math class left.
Figure 18 includes questions to get an idea as to why students don’t want to take the AP test. I compared the responses of students who plan and who do not plan to take the test. The first question aimed to look at how prepared students felt for the AP test. Looking at the students who planned to take the test, they didn’t seem too confident in their preparation. Three responded below “neutral” and six “neutral” only one responded above “neutral.” This could be due to two things. The actually aren’t prepared or their anxiety of such an important test makes them felt unprepared. But looking at the students who don’t plan on taking the test, mostly all of them don’t feel prepared for the test. This is most likely because they don’t plan on taking the test to begin with, but they also might not be taking it because they feel so unprepared. To get a better idea of this problem there is also a graph of how comfortable students feel with the material that will be covered on the test. The students taking the test are more comfortable with the material than how prepared they feel. The lowest response for knowledge of material is “neutral.” This is good because it is a positive movement in how students feel about the test. The same movement occurs in students not planning on taking the test. With these results I get the idea that students feel like they have a decent grasp on the material they just don’t feel they have enough practice. To increase the feeling of preparation the high school teachers could try and include more problem sets in the class. It would be interesting to see how the grades on the test compare to how prepared students felt.

Since I was shocked to see how few students planned to take the AP tests I decided to look at the expected grades in the course. I also wanted to compare these results to the expected grades in Stat 130 since these courses are very closely related. Figure 19 has the graph of expected grades. It is pretty shocking to see that 83.6% think they will get a grade in the A range. With such high expectations I would think more students would plan on taking the AP test. This may also indicate that the class is too easy. Teachers might want to challenge the students more. They could also include harder questions to prepare the students for the AP test. With a grade distribution like this, students will be shocked to see
that college averages range in the 70’s and 80’s. Comparing these grades to Stat 130, AP students feel much more confident in their grades. The expected grades in the AP class seem to be a unrealistic when compared to the Stat 130 grades.

![Chart of question about expected grade](image)

Figure 19 AP students expected grade in the course

The most shocking thing I got of surveying the AP students was the small number of students actually planning to take the test compared with the high expected grades in the course. Most students don’t really feel too prepared for the test but they do have a grasp on the material covered. They do like the use of technology and working in groups. In a course that I would have to teach I would most likely incorporate both of these. From the large number of responses the students feel they struggle most with selecting what testing method to use. To overcome this, it would be good to have a chart to fill in as the class progresses and more tests are acquired.

**What I think an Introductory Statistics Course Should Cover**

From everything I learned an introductory statistics course should model the GAISE guidelines. A course should focus on statistical literacy and develop statistical thinking. This can be done by requiring students to read statistical articles and do projects. A course should also focus on conceptual understanding rather than knowledge of procedures. To accomplish this a course could have more questions on concepts rather than practice of doing tests. Using real data is another important thing to include in a course. Real data can grasp a student’s attention if it is relevant to their life. Clever ways to get real data is collect data about the students and use it throughout the course. Technology should be used in a class because it allows students to explore the data easier and automates calculations. I would include technology so students can visualize data and work with larger realistic data sets. Active learning is another important aspect of learning. I would try to include hands on labs as often as possible. These labs would allow students to work in groups and practice using technology. The labs would also allow student to compile their knowledge from the previous lectures. Lastly, good assessment of students work is crucial to their learning. I would try and provide feedback as quickly as possible while the material is still fresh in a student’s mind. Overall, to have a effective course a professor should follow the GAISE guidelines.
What I learned

Overall I learned a great deal about teaching a statistics course. I learned more on the lines of things to do rather than things to stay away from. The online and in class teaching course taught me different teaching strategies and things that should be included in an intro stat course. I also got exposure to what works well and what a teacher should focus on. All of the data entry helped teach me better ways to organize and format data. As I entered more and more data I realized that there were certain things that should be included so other can look at the data and realize exactly what it is. The first few data files I entered were more tailored to me. Designing all of the surveys helped reinforce my survey design experience. I got better ideas of what kind of questions to ask and how clear to make questions. I also learned that the response rates can be pretty poor even with an online survey sent directly to a person’s inbox. With all the analysis data analysis I learned a great deal about how to use technology in class. In particular how to use applets and including lab work. The one thing I would have liked to get out of my senior project was the chance to actually teach one or two lectures.

Along with the gain in statistical knowledge I also learned other valuable skills. A major one was time management. I learned to work with deadlines and manage my time wisely. I also got a lesson in recording everything I do. Half way through my project I realized I should be taking better notes of what I have done and what I still need to do. Finally I got a lot of practice writing documents and motivating myself to do work. Overall I thought the most difficult thing about the senior project was managing my time and keeping on track with the things I had to do. With all of the other classes I was taking my senior project frequently sat on the back burner simmering.

Conclusion

My senior project was a great way to prepare myself for teaching in graduate school. All of the articles I read gave me pointers on how to teach classes and what should be included in an intro class. The surveys provided opinions of students currently in intro statistics courses and what they liked about the courses. Overall I came to the conclusion that the best way to teach a course is model the GAISE recommendations for teach statistics. From what I read and learned over the project, they model the most effective class. Now all I have to do is put what I learned to the test and teach a course in graduate school.
Appendix

Survey 1: Stat 130 Pre Survey

Thank you for participating in this survey. As part of my senior project I am conducting an educational research study about students' attitudes toward statistics.

This study includes responses to this survey and a survey at the end of the quarter; therefore, I need a way to keep track of your responses. To keep your identity hidden can you provide the last 4 digits of your phone number to be used as an identifier. Your instructor will never see your individual responses, only the summary data at the end of the quarter.

Participation is voluntary. The survey is estimated to take 5-10 minutes. You may discontinue participation at any time. Declining to participate or discontinuing participation will NOT result in any penalty.

-Alex Herrington

1. What are the last 4 digits of your phone number? _______________________________

2. What is your gender?
   ___ Male
   ___ Female

3. Have you taken a statistics course before? (check all that apply)
   ___ No
   ___ Yes, high school AP class
   ___ Yes, high school non-AP class
   ___ Yes, college course
   ___ Yes, college course but did not finish

4. What year are you?
   ___ Freshmen
   ___ Sophomore
   ___ Junior
   ___ Senior
   ___ Other

5. What is your major?_________________

6. Expected grade in this course? ______________
<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. I used Poly Ratings to find information about this professor</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. I chose to take this class because it is being taught in a lecture hall (70+ students) rather than a classroom (25-40 students)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. The learning environment is better in a lecture hall than a classroom</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. I prefer to learn from lecture than to learn from activities</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11. I prefer to take classes in lecture halls</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>12. It is easier for a professor to teach in a lecture hall than in a classroom</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>13. I prefer to work on homework alone</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>14. I prefer to work on projects alone</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>15. I prefer to study for exams and quizzes alone</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>16. I am excited to take this course</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>17. I am interested in learning about statistical ideas</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>18. I am interested in learning how to interpret statistical results</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>19. I am comfortable with my mathematical skills</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>20. Statistics is heavily mathematics based</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>21. I will succeed in this course</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>22. Learning statistics will be easy for me</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>23. I want to take more statistics courses after this one</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>24. Statistics is useful in everyday life</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>25. Statistics will be useful in my field of study</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>26. Statistics should be a course requirement for every major</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
27. What examples of data would you like to see? (select all three)
___Sports
___Pharmaceuticals
___Cancer data
___Smoking data
___Other medical data
___Marketing
___Sales
___Engineering
___Environmental
___Psychology
___Science
___Agriculture
___Other ___________________________

28. If I need help in this course I will go to (select all that apply)
___Office hours
___A tutor
___Other students in the course
___Other students who have already taken the course
___The text book and notes
___Other ___________________________

29. What worries you most about this course and statistics? ____________________________  
_______________________________________________________________________________
_______________________________________________________________________________
_______________________________________________________________________________

Survey 2: Stat 130 Post Survey

Thank you for participating in this survey. As part of my senior project I am conducting an educational research study about students’ attitudes toward statistics.

This survey is the follow up survey from the beginning of the quarter; therefore, I need the same last four digits from the phone number you used in the first survey. Your instructor will never see your individual responses, only the summary data at the end of the quarter after grades have been submitted.

Participation is voluntary. The survey is estimated to take 5-10 minutes. You may discontinue participation at any time. Declining to participate or discontinuing participation will NOT result in any penalty.

-Alex Herrington

1. What are the last 4 digits of your phone number? ________________________________

2. Expected grade in this course? ____________
To what extent do you agree or disagree with each statement?

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Statistics should be a course requirement for every major</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. Statistics will be useful in my field of study</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. Knowledge of Statistics is useful in everyday life</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. I enjoyed learning about Statistics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. Statistics is heavily math based</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. Having class in a lecture hall did not negatively affect my learning</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. If there were not reading quizzes I probably would have not read the book</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. I did not read for understanding, I just searched for the answers for the reading quizzes</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11. Reading quizzes helped improve my understanding of the material</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>12. I benefited from in class quizzes because they showed how much I knew or didn’t know about the course material</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>13. Working in a group on quizzes aided my understanding of the material more than working individually</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>14. Group and open book quizzes were too easy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>15. I did not attempt any of the suggest exercises because they were not collected for a grade</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>16. I attempted most of the recommended exercises</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>17. I reviewed the solutions to the suggested exercises</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>18. It would have been more helpful to have worked out solutions to the recommended exercises rather than just answers</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>19. The exercises should have been collected so I would be forced to do them</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>20. Mini projects reinforced my understanding of the material</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>21. The feedback on graded assignments helped me better understand the material</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>22. Daily handouts with fill in areas are better than writing notes on completed power point slides</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>23. Daily handouts with fill in areas are better than copying everything a professor says and writes on the board</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Survey 3: Stat 150 Survey

Thank you for participating in this survey. As part of my senior project I am conducting an educational research study about students’ attitudes toward statistics.

Participation is voluntary. Your responses will be kept anonymous. The survey is estimated to take roughly 5 minutes. You may discontinue participation at any time. Declining to participate or discontinuing participation will NOT result in any penalty.

1. What is your gender?
   ___Male
   ___Female

2. What year are you?
   ___Freshmen
   ___Sophomore
   ___Junior
   ___Senior
   ___Other

3. Have you taken a statistics class before Stat 150?
   ___Yes in high school
   ___Yes in college
   ___Yes both high school and college
   ___No

4. Grade in Stat 150 course? ____________
# To what extent do you agree or disagree with each statement?

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Stat 150 was a good introduction to the discipline <strong>statistics</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. I have an idea of what will be taught in my other statistics courses</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. I know how statistics can be applied to various fields</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. I know how statistics is used in daily life</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. I was excited to take statistics courses before taking Stat 150</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. After Stat 150 I am more excited to continue with my major in statistics than before taking the class</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11. I want to get more involved in Stats Club</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>12. I would like to see more Stats Club events and meetings</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>13. Stats Club is too nerdy for me</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>14. The statistics department is a friendly and warming place</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>15. I would like to get to know the faculty better</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>16. I would like to get to know the Junior and Senior stats majors better</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>17. I would like to get to know the Freshmen and Sophomore stats majors better than I already do</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>18. I am familiar with the stats lab near the faculty offices and statistics department office in building 25</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>19. The statistics course flowchart aids me when it comes time to register for classes</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>20. Faculty advisors provide useful information so I can graduate in 4 years</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

21. I am not involved in Stats Club because (choose all that apply)
___ I am already involved in stats club
___ I don’t have enough time
___ I don’t know anyone in the club
___ It is too nerdy for me
___ It is boring
___ I don’t know what they do in Stats Club
___ Other
22. What made you decide to major in statistics?

23. What worries you most about majoring in statistics?

Survey 4: First AP Survey

Thank you for participating in this survey. As part of my senior project I am conducting an educational research study about students’ attitudes toward statistics.

This study includes responses to this survey and a survey at the end of the term; therefore, I need a way to keep track of your responses. To keep your identity hidden please provide the last 4 digits of your phone number to be used as an identifier. Your instructor will never see your individual responses, only the summary data over the summer.

Participation is voluntary. The survey is estimated to take 5-10 minutes. You may discontinue participation at any time. Declining to participate or discontinuing participation will NOT result in any penalty.

If you have any questions or concerns please email me at herringt@calpoly.edu

-Alex Herrington

1. What are the last 4 digits of your phone number?________________________

2. What is your gender?
   ___ Male
   ___ Female

3. What year are you?
   ___ Freshmen
   ___ Sophomore
   ___ Junior
   ___ Senior
   ___ Other

4. Are you planning to take the College Board AP Statistics test in May?
   ___ Yes
   ___ No
   ___ Don’t know
   ___ Depends on __________________

5. Have you taken Calculus?
   ___ Yes, previously
   ___ No
   ___ Currently enrolled

6. Have your previous experiences in mathematics courses been generally positive, negative, or mixed?
   ___ Positive
   ___ Negative
   ___ Mixed
7. Expected grade in this course? ____________

To what extent do you agree or disagree with each statement?

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>I am excited to take this course</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>I want to take the AP test so I do not have to take statistics in college</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>I would rather take AP statistics over AP calculus</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>11</td>
<td>Statistics is more interesting than calculus</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>Statistics is easier to learn than calculus</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>13</td>
<td>Statistics is more useful than calculus</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>14</td>
<td>Statistics is more useful for my desired field of study than calculus</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>15</td>
<td>I plan to take more statistics courses in college</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>16</td>
<td>I understand how statistics can be applied in the working world</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>17</td>
<td>I understand how calculus can be applied in the working world</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>18</td>
<td>Statistics is useful in everyday life</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>19</td>
<td>I am interested in learning how to interpret statistical results</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>20</td>
<td>I am comfortable with my mathematical skills</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>21</td>
<td>Statistics is heavily mathematics based</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>22</td>
<td>I prefer to work on homework alone</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>23</td>
<td>I prefer to work on projects alone</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>24</td>
<td>I prefer to study for exams and quizzes alone</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

25. Other comments? _______________________________________________________________

_______________________________________________________________________________

_______________________________________________________________________________
Survey 5: AP Survey Right Before AP Test

Thank you for participating in this survey. As part of my senior project I am conducting an educational research study about students' attitudes toward statistics.

Participation is voluntary. The survey is estimated to take 5-10 minutes. You may discontinue participation at any time. Declining to participate or discontinuing participation will NOT result in any penalty.

If you have any questions or concerns please email me at herringt@calpoly.edu

-Alex Herrington

1. What is your gender?
   ___Male
   ___Female

2. What year are you?
   ___Freshmen
   ___Sophomore
   ___Junior
   ___Senior

3. Are you planning to take the College Board AP Statistics test?
   ___Yes (answer question 4)
   ___No (answer question 5)

4. I am taking the Statistics AP test because (select all that apply)
   ___I will get college credit so I will not have to take statistics in college
   ___My parents are forcing me to take it
   ___I am confident that I will pass the test
   ___Statistics is easy
   ___I have enjoyed the class and want to see how well I can score

5. I am not taking the AP statistics test because (select all that apply)
   ___I don't feel the course prepared me for the test
   ___I don't want to put in the time and effort to study for the test
   ___Too expensive
   ___The college credit will not help me with my major in college
   ___I don't like statistics
   ___Statistics is too hard
   ___Bad schedule time

6. Have you taken Calculus?
   ___Yes, previously
   ___No
   ___Currently enrolled
7. Have your previous experiences in mathematics courses been generally positive, negative, or mixed?
___Positive
___Negative
___Mixed

8. Expected grade in this course? ______________

To what extent do you agree or disagree with each statement?

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. Statistics is more interesting than other math courses</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. Statistics is more useful in everyday life than other math courses</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11. Statistics is interesting because it affects our lives daily</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>12. I enjoy the application of statistics more than the theory</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>13. Statistics is difficult to understand and learn because there is no definitive answer</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>14. Choosing the correct testing method can be a challenge</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>15. Probability concepts are not as interesting as data analysis (ie hypothesis testing and graphical displays)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>16. I understand how statistics can be applied in the working world</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>17. Statistics is useful in everyday life</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>18. Statistics will be useful in the field of study I want to go into</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>19. The AP statistics test will be easy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>20. I am well prepared for the AP statistics test</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>21. I am comfortable with the material covered in the AP statistics course</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>22. There were very few statistics topics that were difficult to understand</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>23. Learning statistics was easier than I originally thought</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>24. I look forward to taking a statistics course in college</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>25. Use of technology (ie graphing calculators or computer software) aided in my understanding of statistics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>26. Working in groups has been useful in my learning of statistics</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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</tbody>
</table>
27. I relied on homework and reading the text book to teach myself statistics

28. Why did you choose to take AP Statistics?

29. What was the most difficult topic to understand in statistics? Why?
References

**Becoming a Teacher of Statistics Course**

**Professors:**

Beth Chance and Michelle Everson

**Students:**

Samuel Hintz, Becky Johnson, Micah Stohlman, Daniel Swensen, Afek Taragan, and myself

**Text books:**


**Statistics education section:**


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**Using real data section:**

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**Conceptual understanding and statistical reasoning section:**


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Shaughnessy and Chance textbook: Chapter 10

**Statistical literacy and statistical thinking section:**


Gelman and Nolan textbook: Chapter 6


**Active learning section:**

Gelman & Nolan text, Chapter 11, pp. 167-175


**Using technology section:**


**Assessment section:**


Teaching Statistics Course

Professors:

Beth Chance, Allan Rossman, and Soma Roy

Students:

Alyssa Eubank, Sasha Kravets, Blanca Lopez, Crystal Macias, Jessica Meyers, Julia Schedler, Lauren Soltesz, and myself

Goals of teaching section:


Statistical literacy and statistical thinking section:

“What Educated Citizens Should Know About Statistics and Probability” by Jessica Utts

"Unintentional Lies in the Media: Don't Blame Journalists for What We Don't Teach," by Jessica Utts

“Statistics Among the Liberal Arts” by David Moore
http://www.stat.purdue.edu/~dsmoore/articles/LibArts.pdf

How statistics is different from mathematics section:


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video titled “Arthur Benjamin's Formula for Changing Math Education,”

**Cooperative learning section:**

"Collaboration in Learning and Teaching Statistics," by Roseth, Garfield, and Ben-Zvi

**Assessment section:**


"Rethinking Assessment of Student Learning in Statistics Courses," by Garfield, Zieffler, Kaplan, Cobb, Chance, and Holcomb. This article, which appeared in the February 2011 issue of The American Statistician

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**Teaching issues section:**

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George Cobb, called "The Introductory Statistics Course: A Ptolemaic Curriculum?" available at: http://escholarship.org/uc/item/6hb3k0nz.

**Educational research section:**


Louis Deslauriers, Ellen Schelew, Carl Wieman, “Improved Learning in a Large-Enrollment Physics Class”, journal Science 2011

**Additional Readings**

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GAISE *Goals for students in an introductory course: What it means to be statistically educated*

John Holcomb *Introducing concepts of statistical inference via randomization test*

Beth Chance *Assessing Student Learning About Statistical Inference*

Allan Rossman, Beth Chance, Else Medina *Some key comparisons between statistics and mathematics and why teachers should care*
Jessica Utts *What educated citizens should know about statistics and probability*

Jennifer Green *Teaching highs and lows: exploring university teaching assistant’s experiences*

**Additional References**

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Schau, Candace, (2003), *Post SATS – Spring 2009*