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EDPS 859: Statistical Methods—A Peer Review of Teaching Project Benchmark Portfolio

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Peer-Review of Teaching Project

Benchmark Portfolio

for

EDPS 859 Statistical Methods

Spring 2015

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Benchmark Memo #1

Description of the Course: EDPS 859 Spring 2015

EDPS 859 *Statistical Methods* (see [Appendix A](#) for syllabus) is a graduate-level introductory statistics course that surveys a variety of basic statistical methods (i.e., descriptive and inferential statistics including t tests, ANOVA, and multiple regression) and is designed for graduate students who have never taken a statistics course before or who need a refresher course in introductory statistics. The course may be used as a prerequisite for taking more advanced statistical courses (e.g., EDPS 941 *Experimental Methods* [i.e., ANOVA]), as the first course in a two-course introductory statistics sequence (the second course in the sequence is EDPS 860 *Application of Selected Advanced Statistics*), or may serve as the only statistics course a student will take at the university level. The course is primarily a service course for the eight departments in the College of Education and Human Sciences (CEHS), but is open to students outside of CEHS. The course is offered every semester and over the summer, both in an in-person format and an online-only format, by a variety of instructors. The in-person sections are usually capped at 30 students. Occasionally, this course is cross-listed as EDPS 459/859. There are no prerequisites for the course other than basic math skills.

Issues with the Course

There are several practical issues that present difficulties in teaching EDPS 859. Based on the previous times I have offered the course and conversations with other instructors, the students tend to be quite diverse in terms of background, major, and degree being sought. For example, the last two times I taught the course I had students from Chemistry, Architecture, Educational Psychology, Teacher Learning and Teacher Education, Educational Administration, Construction Management, and Spanish, in addition to many others. There are also a mix of students seeking terminal master's degrees, PhDs, and non-degree seeking students in the course. In general, I consider having a diverse student body in a course to be a benefit, but it is also problematic in that it is impossible to present examples that are related to every student's unique background, to make any assumptions regarding what students do and do not know about a specific field (e.g., psychology), or the student's goals for the class.

The two consistent factors in the course are that most of the students had never taken a statistics course before and that the majority are in the course because it meets a degree requirement. Never having had a statistics course before is not an issue with regards to prerequisites because EDPS 859 is designed as a truly introductory course, but it can become an issue for students who assume that *Statistics = Math* and who have convinced themselves that math is too hard for them (i.e., they cannot *do* math). This problem is so large that some students may have chosen their undergraduate majors specifically because the major did not have a math or statistics requirement. This problem also extends to the use of statistical software packages which are seen as being too difficult to use instead of as useful tools to generate statistics. Being a required course presents a different type of challenge because students may be resentful they have to take the course when they could be taking more *important* courses related to their degree or just see it as a requirement to be checked off and forgotten. Many students have never conducted research before taking EDPS 859 (and some never will) which means a lack of understanding of how statistics fit into research. In addition, EDPS 859 is a statistics course, not a research methods course. There is no expectation by the instructor or requirement that students have taken a research methods course prior to or concurrently with EDPS 859. With no knowledge about research or how to conduct it, there is no context for the statistical methods covered in the course. Many faculty, however, recommend that students take EDPS 859 their first semester at UNL, prior to taking a research methods course.

The final major issue with the course is that EDPS 859 is a service course for CEHS and the rest of the university. This means that faculty in other departments expect certain topics and software to be covered in the course. It also means the same textbook is used in all sections of the course, regardless of whether an individual instructor has what they consider to be a better book (not that the textbook currently used is necessarily any worse than other introductory statistics texts), and the same statistical software (SPSS) is used in all sections, regardless of whether the individual instructor considers it to be the best software. Attempts to change either of these features of the class are often met with resistance. To paraphrase one faculty member in

another department, “I send students to that course to learn how to use SPSS, period.” As the instructor, I have different course objectives than just teaching the students to use one statistical software package independent of context or interpretation. In addition, as a survey course, there are a large number of topics to be covered, so there is rarely enough time to go more in-depth into a specific statistical technique in which the students may be interested.

Course Objectives

As the instructor of a section of EDPS 859, I have four main course learning objectives, each with two sub-objectives. My first main course objective is that after the course: ***the students are able to be critical consumers of statistics in published research and the popular press***. The two sub-objectives necessary to achieve this main objective are: *students are able to correctly interpret reported statistics and students are able to identify potential problems that accompany using a specific statistical technique*. Whether a student is planning to take more statistics courses or not, whether they are planning to conduct research or not, a student should be able to read a journal or newspaper article that uses one or more of the statistical techniques discussed in the course and understand both the meaning of the statistics presented as well as potential pitfalls that accompany using these statistics.

My second main course objective is that after the course: ***the students know which statistics are appropriate for different types of data and/or studies***. The two sub-objectives necessary to achieve this main objective are: *students understand what makes a specific statistic appropriate for a specific study or set of data and students understand the assumptions that accompany a specific statistical method*. In order to be critical consumers or producers of statistics, students need a more general knowledge of various statistical techniques and the assumptions behind each technique.

My third main course objective is that after the course: ***the students are able to run statistics on real data***. The two sub-objectives necessary to achieve this are: *students are able to generate specific statistics by hand and using statistical software and students are able to interpret statistics and identify the relevant information in the output from a statistical software package*. In addition to being critical consumers, ideally the students should also be producers of statistics, which means that the students need to be able to use at least one statistical software package to generate statistics on a data set and be able to identify the statistics they produced in the output from the statistical software package. In addition, the students should understand that statistical software packages are tools to generate statistics, nothing more. Therefore, the particular software used is irrelevant, provided the correct statistics can be computed.

My fourth main course objective is that after the course: ***the students understand the importance of statistics in research***. My two sub-objectives necessary to achieve this main objective are: *students understand the integral role of statistics in research and students have developed the self-efficacy to continue to improve their training in statistics*. As a quantitative psychologist, I see each additional methodology course a student takes, quantitative or qualitative, as one more tool the student has to understand and conduct research. Each additional technique they learn allows them to ask and answer theoretical questions in new ways; that is, it allows them to attack a problem from multiple sides simultaneously. By emphasizing the importance of methodology in research and focusing on building student self-efficacy in my courses (Yes, you can do statistics!!!), I hope to encourage students to take more advanced methods courses, including my own.

Why EDPS 859?

The reason I chose to create a benchmark teaching portfolio for EDPS 859 is that it is forcing me to re-evaluate the objectives of the course as well as how I try to reach these objectives. Currently I teach the course as a lecture/exam course with three equally spaced, equally weighted exams and eight homework assignments that require the student to analyze a small data set using statistical software and answer questions using the output. Increasingly, however, I find that students leaving the course really cannot relate the statistics back to their own research questions. They cannot identify the appropriate information on statistical software output. And they cannot identify or run the appropriate statistics given a data set and a description of the study from which the data come. I believe the reason for this is that the students are focusing too much on the equations and mathematical assumptions behind the statistics (i.e., *the math*) in order to do well on the exams and not enough on what the numbers mean or how they relate to research in general (i.e., the reason we do *the math*). I also believe the reason for this is that I personally focus too much on the equations in the lectures and on the exams (although this is somewhat a *chicken and egg* situation since the students want me to focus on the material that will be on the exams) and not enough on the interpretation or bigger picture, which is really limited to the homework assignments that they complete outside of class and which we do not always discuss in class.

The key goal of creating this benchmark teaching portfolio then is to identify what my course objectives for EDPS 859 really are and to revise my current course materials, activities, and evaluations to emphasize what I consider to be important in the class in order to better meet the course objectives. I would like this portfolio to serve primarily as a way for me to identify and address issues with my particular sections of EDPS 859. The secondary purpose of this portfolio is to provide information regarding the purpose and placement of EDPS 859 as a service course within CEHS and the university in order to start a conversation about the structure of the course overall. Finally, I would like this portfolio to indicate to the other faculty in my department and at the university not only my dedication to teaching, but also my dedication to actively improving my teaching, as well as (hopefully) serving as a supporting document for a future teaching award nomination and tenure.

Benchmark Memo #2

Exams

The largest change in the way I am teaching the EDPS 859 course in Spring 2015 is the removal of all exams from the course. The exams were problematic in that students focused almost exclusively on the content of the exams (i.e., *Will this be on the exam?*) to the exclusion of everything else. Students were routinely stressed about the exams from the first day of class, which caused them to be less open to the possibilities that a good background in statistics provided for their research. The in-class, timed (i.e., had to be completed by the end of the class period), closed-book nature of the exams was also very artificial. If the student were conducting these statistics on their own data, they would have unlimited time and the ability to look at all of the resources from the course. My own experience has shown me that open-book, in-class exams can be problematic as students spend all of their limited time trying to look up facts. In order to alleviate both these problems, some faculty give open-book, take-home exams. To me, this is essentially the same as completing a homework assignment but with the added pressure of it being called an *exam*, so I instead chose to increase the number of statistical homework assignments (described later) that had to be completed from eight to sixteen (one per topic) and completely remove the stigma of the word *exam* from the course.

An additional benefit of not giving exams was the time this freed up to cover other topics. In prior offerings of EDPS 859, there were three exams, each which took up an entire class period, and three review sessions, each of which also took up an entire class period. As the third exam was taken during the university scheduled final exam time during Finals Week, this meant I was spending five 75-minute class periods (two exams, three review sessions) focused just on the exams. By removing the exams, this freed-up two and a half weeks of time to focus on content and context, specifically being able to discuss the additional reading assignments (described later) in class and provide more examples.

Textbook, Lectures, and Textbook Handouts

Even with the move away from exams in the current version of the course, this course is still primarily textbook/lecture based. As the course is taught by multiple instructors, in order to achieve some balance in terms of the content taught, each instructor covers the first sixteen to seventeen chapters in the textbook (Gravetter & Wallnau, 2013), though I have never had time to cover Chapter 17 when I teach the course. I am a firm believer in requiring textbooks in my courses. In this course, the textbook serves several purposes. First, I recommend the students read the relevant chapter prior to attending class, even if they do not understand everything they read, in order to be introduced to terms and concepts we will discuss during the lecture. Second, there are many topics or details that do not make it into my lectures (due to time or lack of importance to me as the instructor) that may be important for specific students, so having the textbook to refer to is important. Third, all of the equations and example data sets we discuss during the lecture come directly from the textbook, as do many of the figures and tables, so having the textbook allows the student to go back over the examples on their own. I also provide photocopies of relevant statistical tables from the textbook for the students. This allows us to work out examples in the textbook/lectures in class without the student having to bring their textbook and it allows the students to write notes or circle things in the tables without having to write in their books.

For each chapter we cover in the book, I prepare a set of PowerPoint slides (sixteen sets in all) from which I lecture and present examples that we work through in class. These slides are provided to the students prior to the lecture. While admittedly not the most dynamic teaching tool, I use PowerPoint for a variety of reasons. First, the course is heavily equation and figure based, so they provide a nicely formatted, easy to read method for working our way, step-by-step, through examples. Second, the slides allow me to emphasize the points in the textbook that I feel are most important or most relevant and de-emphasize other points in the textbook. Third, the slides allow me to add additional details, terms, concepts, and examples that are not in the textbook. Fourth, the slides allow me to make connections between topics covered in a specific chapter with topics covered in other chapters or the assignments the students complete outside of class. Finally, and most important to me, the slides allow me to ask the students questions, the answers to which lead to the information on the next slide. I like this because it reinforces the logicalness, linearity, and practicality of the statistical methods we are discussing. In fact, my favorite thing when I teach is when a student asks a question about material that will be covered on the next slide because it shows that the student is thinking critically and knows what should come next.

Statistical Handouts and Assignments

In addition to the in-class lectures and examples, the students are also required to complete two sets of assignments to be completed outside of class. The first set of assignments that are completed outside of class are a series of statistical (STAT) assignments that require the students to apply the statistical methods they are learning about during the lecture (an example statistical assignment is presented in [Appendix C](#)). This is the *how to use statistics* part of the course. There are sixteen STAT assignments, one per lecture/chapter, that require the students to complete several short-answer questions, compute specific statistics by hand on a small example data set, then use a statistical software package (in this case SPSS) to analyze the data a second time, and finally interpret the results of the statistics they ran in terms of the original variables and research hypotheses. Students are allowed to work in groups of up to three for each STAT assignment. For each STAT assignment, the students are also provided an illustrated/annotated example (sixteen in all) of how the specific analyses can be conducted using the SPSS software.

There are many things I find particularly beneficial about this format. First, requiring the students to apply the methods they are learning in class allows them to discover whether they actually understand the method as well as they might have thought. Second, by computing the statistics first by hand, then by computer, the students learn that the statistical software is not *magic* – the numbers in the output come from the equations in the lectures/textbook. That is, it drives home the idea that the student's choice of statistical software is irrelevant in most cases as the software is just a tool that alleviates the need to compute everything by hand. Third, re-computing the statistics using the computer allows the students to check their hand calculations for accuracy, though often the students find that their hand calculations are correct but they ran the wrong analysis in SPSS. Finally, by requiring the students to interpret the results, the gap between the statistics and the research is narrowed, emphasizing the point that statistics are a tool to answer research questions, nothing more.

Additional Reading Assignments

While the lectures and STAT assignments address the *how* of statistics, they do not address the *why*. The second set of assignments that are completed outside of class involve a series of additional readings related to the broader content of the course that discuss the role of statistics in research and the media, and present *big picture* ideas that are not directly addressed in the textbook, lectures, or statistical assignments. The additional readings vary in length, content, and source, and include a magazine article, an excerpt from a publication manual, book chapters, and peer-reviewed journal articles. For each of the fourteen additional readings (approximately one per week), the students are required to complete five short-answer questions related to the reading, which is how I make sure they have done the reading (an example additional reading [AR] assignment is presented in [Appendix D](#)). I allow the students to work in small groups of up to three when answering the questions for the additional readings because I want to encourage them to discuss the readings with each other, particularly things they may not understand after a first reading. The students are given one week to complete each AR assignment. On the date the questions are due, we discuss the reading and the questions in class, which usually takes between fifteen and twenty minutes. I have the students keep their answers in front of them while we discuss the reading and I allow the students to add things that come up during the discussion to their answers, but I ask them to not cross out or change anything in their original answer. After the in-class discussion, the students turn in their answers and I grade them.

The additional readings are specifically selected and ordered to complement the content in the lectures and STAT assignments. The first reading by Kazdin (2003), titled *Methodology: What it is and why it is so important*, explains the difference between the statistics course the students are currently taking, which is focused on the analysis of quantitative data, and a research methods course that focuses on designing and conducting research studies more generally. It also makes the points that methodology is really just a series of strategies that help deal with common problems that occur when conducting research and that statistics are just one of many tools for conducting research. The second reading (Best, 2001a) introduces the idea that no matter how objective someone creating a statistic may be, the statistic was still created for a specific purpose, so who created a statistic and why it was created are very important questions to consider when interpreting a specific statistic. This idea is furthered by the third reading (Best, 2001b) which makes the points that many statistics are just estimates (e.g., the number of homeless youth in the US) and that the accuracy and usefulness of this estimate depends, among other things, on the operational definition used by a specific researcher (e.g., there are many different ways to define *homeless*). In addition, the students are introduced to the idea of *number laundering* which is the idea that once a statistic has been reported, people will continue to repeat that statistic with little regard for the origin or accuracy of the statistic as long as it supports their point.

The primary purpose of the second and third readings is to drive home the idea that no statistic the student encounters should be taken at face value, but instead must be questioned. In order to determine the relative accuracy and worth of a statistic, the student needs a lot of

contextual background information. The fourth reading is an excerpt from the American Psychological Association's publication manual (APA, 2010) which lays out the information that should be included whenever statistics are reported for a research study. The questions for the fourth reading lead the student to realize that the information required in a research article is the same information that is required to judge the relative accuracy and importance of a statistic that was described by the second and third readings. The fifth reading (Best, 2004) changes gears slightly to discuss how many researchers lack a sufficient level of *statistical literacy*, which is the ability to not only create accurate statistics, but more importantly judge and interpret statistics presented by others. The sixth reading (Aiken, West, & Millsap, 2008) furthers this discussion by presenting data showing that most psychology PhD programs require less than one full year of statistics/methods training and that only a small percentage of universities have dedicated degree programs for training people in quantitative methodology. I also take this opportunity to discuss various statistics courses, minors, and certificates in statistics that are offered at UNL and in which the students may be interested. These first six additional readings serve to make the students more critical consumers of statistics while they are learning about basic descriptive statistics.

After descriptive statistics, the focus of the course changes to inferential statistics, as do the remainder of the additional readings. An important part of inferential statistics is probability. The seventh reading (Belkin, 2002) illustrates the difference between the actual probability of an event occurring compared to the *perceived probability* of that event. For example, the probability of flipping a coin ten times and getting the sequence *HTHTHTHTHT* is the same as the probability of getting the sequence *HHHHHHHHHH*, but people perceive getting ten heads in a row as being rarer. The eighth reading (Tversky & Kahneman, 1971) extends this point by showing that the idea of a *hot streak*, known as the *gambler's fallacy*, is not supported by probability theory. That is, if two events are independent of one another, such as flipping a coin or getting a specific hand of cards, then the previous result has no impact on the next result. Another important part of inferential statistics is the idea of generalizing the results from a specific sample to the greater population. The ninth reading (Cozby, 2001) discusses the problems that occur when one is using a college-aged, culturally homogeneous sample in a laboratory-based setting and then tries to generalize to a more general population, such as all adults. This reading also emphasizes the importance of replication in research and introduces the idea of a meta-analysis.

The next two readings deal with null hypothesis significance testing (NHST), a common component of inferential statistics in the social and behavioral sciences, that is not without its problems. The tenth reading (Thompson, 1999) discusses several criticisms of NHST and responds with recommendations for avoiding making these mistakes. The eleventh reading (Cowles & Davis, 1982) has the student consider the origins of the ubiquitous .05 Type I error level that a vast majority of researchers use without ever considering why. Continuing with the idea of origins, the twelfth reading (Salsburg, 2001) discusses the origin of the *t* test (developed to increase consistency in batches of beer at Guinness Brewing company) and analysis of

variance (developed to determine whether different types of soil and fertilizers changed wheat and potato yields) to illustrate that different statistics were developed to deal with different real-world research issues. This also illustrates the idea that the more statistical methods one has learned about, the more tools one has to conduct research. At this point in the course, the students are learning about correlations and multiple regression, so the thirteenth reading (Stigler, 2005) explains why they cannot conclude causation based solely on correlations. Finally, the fourteenth reading by Cohen (1990), titled *Things I have learned (so far)*, summarizes the course and discusses best practices for using statistics in research such as preferring simple statistical models to more complex ones and never letting the statistics drive the research – only use statistics to answer one’s original research questions.

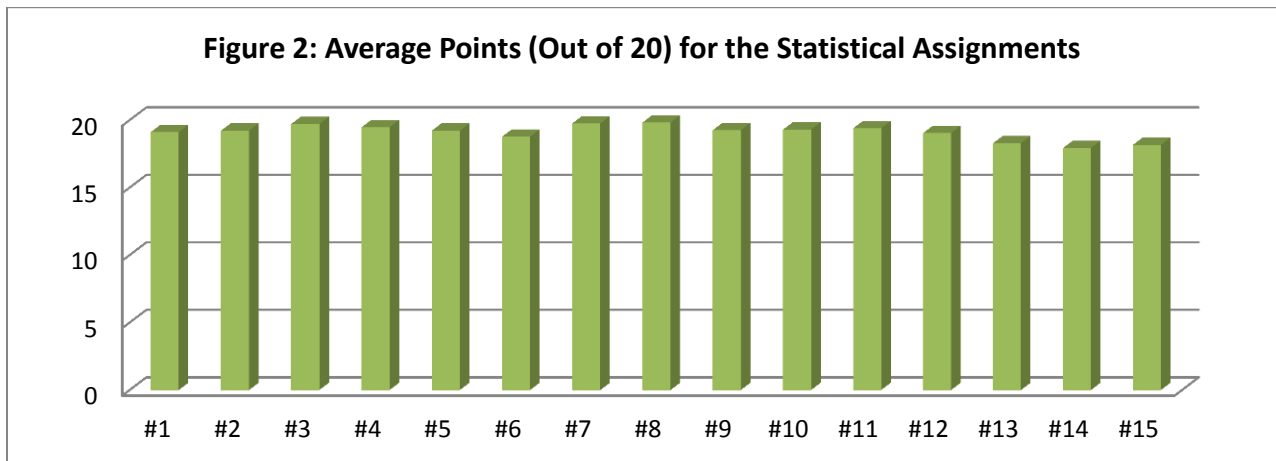
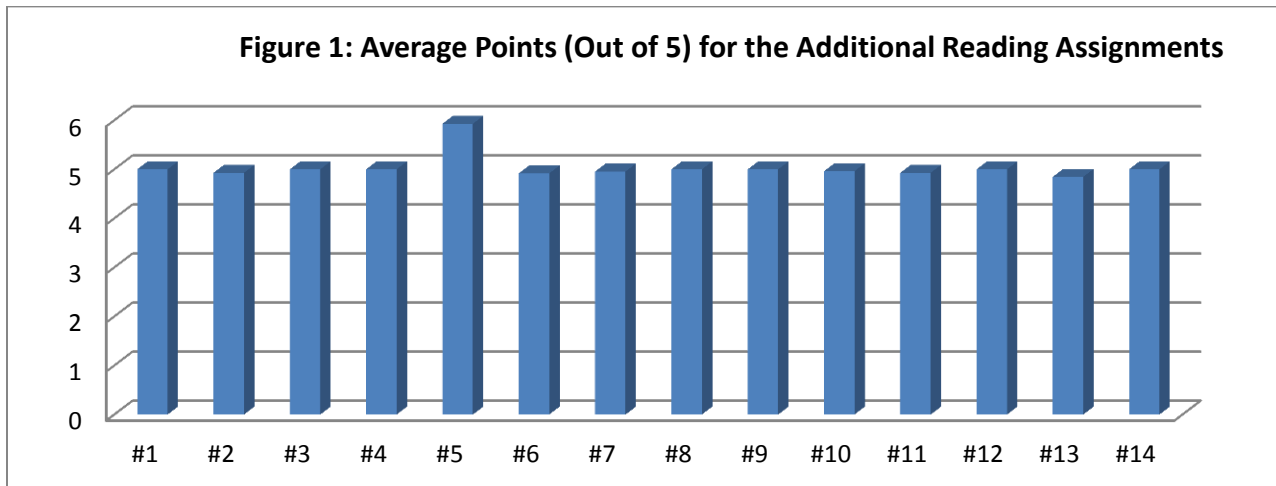
Benchmark Memo #3

Overall Grades

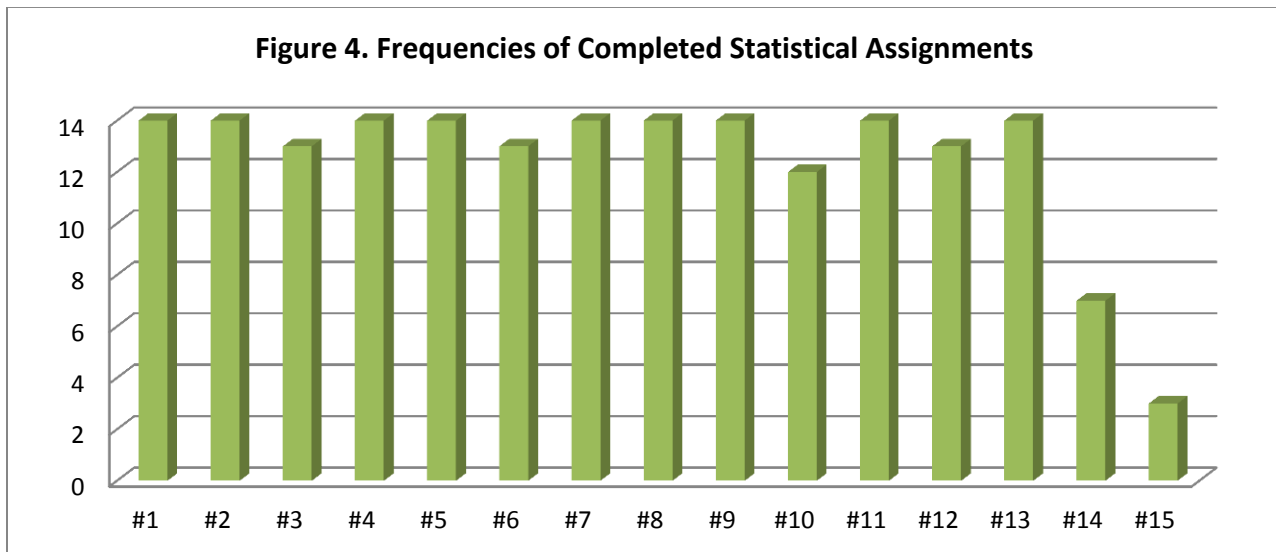
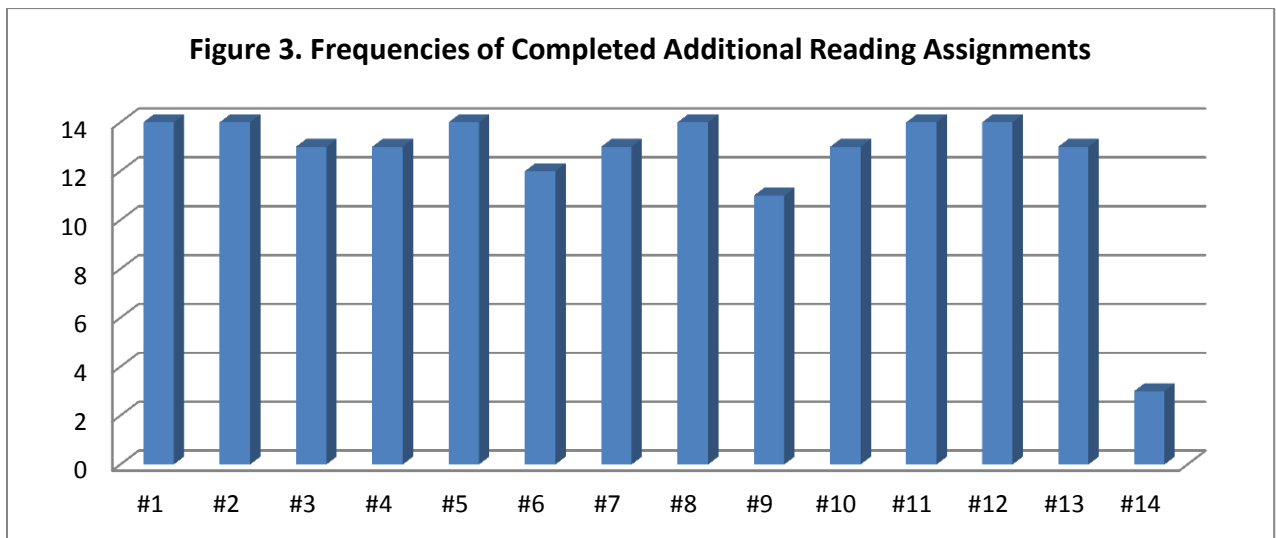
Of the fifteen students who enrolled in the Spring 2015 offering of EDPS 859, fourteen completed the course – the fifteenth student withdrew from the course during the second week due to a change in career plans. The overall distribution of grades for the course was quite good with thirteen students receiving an A and the fourteenth student receiving an A-. This was an improvement over previous offerings of the course where many students received B's or C's.

Assignments

Though originally the syllabus specified sixteen additional reading (AR) assignments and sixteen statistical (STAT) assignments, due to time constraints and instructor travel, only fourteen AR assignments and fifteen STAT assignments were assigned. The overall scores on all assignments were quite high with the means for all assignments being over 90% correct as shown in Figures 1 and 2. Note that AR Assignment #5 had a bonus question, for a total of 6 possible points.



Students were not allowed to turn in late assignments, but they were allowed to drop their two lowest AR and STAT assignment scores. This meant that students could chose to not turn in two AR assignments and two STAT assignments, with no negative effect on their grade. They were encouraged, however, to complete all assignments and to try to improve their grade by getting higher scores on the later assignments. Another incentive was the awarding of bonus points for students who turned in all assignments. While this structure was meant to provide flexibility for travel and illness, this also meant that students who turned in the first twelve AR assignments and the first thirteen STAT assignments, and where satisfied with their scores on these completed assignments, did not have to turn in the last two AR or STAT assignments. Unfortunately, there was a considerable drop off in the number of assignments turned in at the end of the semester as shown in Figures 3 and 4, though Figures 1 and 2 show the quality of the assignments that were turned in at the end of the semester did not diminish.



Ticket Out of Class

Around halfway through the class, I gave an anonymous, six-question mid-semester evaluation in class that I call the Ticket Out of Class (TOC); an example TOC is in [Appendix B](#). The TOC is designed to assess student attitudes toward the class, help determine if there are any issues in the class that need to be discussed, and, if possible, resolve these issues for the second half of the course. The results from the TOC are then discussed with the students.

Question #1: For me, the material in the class is being covered:

	X (min)	X (mean)	X (max)
Too Slowly		Just Right	Too Fast

Question #2: I believe that for the other students in the class (not including myself) the material in the class is being covered:

	X X X	
Too Slowly	Just Right	Too Fast

Based on the responses to Question #1, the material was being presented at approximately the right speed for most people (though in general I would prefer the mean to be a bit above Just Right), but for some students the course was moving too slowly and for others it was moving much too fast. The range was much less for Question #2 which asked about the student’s perception of the speed of material for the other students in the course. I like these questions because it makes the students think about the other people in the class and that the course is not just about them. So, for every person that wants the course to be faster, there is someone who wants it to slow down.

Question #3: The thing I dislike the most about this class is:

The responses to Question #3 fell into two broad categories. The first were responses that either stated there was nothing they disliked about the class (“Nothing. This class is very well designed.”) or issues that were beyond my control (“The parking situation.”). The second category of responses dealt with the class assignments: “The homework doesn’t seem to be spaced out evenly”, “Having to use SPSS when more useful and abundant software is available”, “Some of the additional reading assignments can be too long.” As part of the in-class discussion of the responses, we identified which of the comments the students considered important (e.g., spacing of homework) and which were less important and more a function of having to provide

an answer about something they disliked (e.g., reading assignments too long). For the next offering of the class, I plan to re-examine the spacing and length of the assignments.

Question #4: The thing I like best about this class is:

The responses to Question #4 also fell into two broad categories. The first addressed the overall format of the course, specifically the assignments and lack of exams: “No tests”, “The use of SPSS in conjunction with the assignments”, and “The additional readings, the fact that there are assignments which encourage group work in place of examinations.” The second mentioned my lecturing style: “I like the way the professor teaches the class. He is very clear and engages the students” and “The professor takes the time to fully explain things, from the extremely detailed lecture notes to the class discussions”. The fact that the students recognize the utility of the assignments is very encouraging. I also believe adding the AR assignments and discussing them in class has done a lot to promote learning by placing the mathematical part of statistics in the broader context of research.

Question #5: If I could change one thing about this class it would be:

For Question #5, there were several students who indicated they would not change anything about the course. For the rest, it was mainly things they would add to the course, rather than explicitly change or take away: “Time to practice calculations in class”, “I will add more homeworks in Part 2 of each assignment”, and “More think-pair-share focus questions”. There were also a few students who had less specific changes: “Creating a way to better understand applications of statistics”. Most of these comments concerned the assignments and match up well with Question #3, reinforcing the need to re-examine the content and spacing of the assignments for the next course offering.

Question #6: What could I do personally to make this class better for me?

Question #6 is there to remind the student that they are an active participant in their own learning. The vast majority of the responses concerned the students spending more time outside of class reading and reviewing the material so they could follow the lectures better (“Maybe read the lecture notes before class more regularly than I do now”), though one student noted they could “Contribute more by asking questions on things that are not clear enough to me after the [sic] explains in class”.

Overall, the TOC indicated that the material was being covered at an appropriate rate. The students liked the course materials and assignments, but the length, spacing, and content of the assignments could be improved to better their understanding of the material.

Learning Objective #1

The first main course objective is that after the course: ***the students are able to be critical consumers of statistics in published research and the popular press***. The two sub-objectives necessary to achieve this main objective are: *students are able to correctly interpret reported statistics* and *students are able to identify potential problems that accompany using a specific statistical technique*. These two sub-objectives were achieved/assessed jointly through the AR and STAT assignments.

When asked in AR #2 to identify *What are the three questions Best says you should ask whenever you encounter a new statistics?*, one student replied:

- 1.) Who created the statistic?
- 2.) Why was the statistic created?
- 3.) How was the statistic created?

The students were then required to find a statistic in the popular press (e.g., a newspaper story) and try to answer all three of these questions. Students found that many of the statistics they found did not provide enough information to answer all three questions satisfactorily. This idea was extended in AR #3 where the students were asked to define *the dark figure*, *number laundering*, and *operational definitions* to which one student replied:

[The dark figure] is the difference between the number of officially reported/recorded crimes and the true number of crimes. [Number laundering of a statistic] starts as someone's best guess, but along the way it gets distorted [because p]eople begin to report the number as fact and assume it is correct because it appears frequently in media sources. [For operational definitions, n]o definition is better than another; it depends on what the researcher is trying to measure... broader definitions lead to larger numbers so we should always ask: 'How is the problem defined?' and 'Is the definition reasonable?'

AR #4 discusses the required information reported in a published research article. The students were then asked how this information relates back to AR #2 and #3: *[W]hy does the APA require all of this information?* One student wrote:

If the three big questions of statistics are, "Who, Why, and How were statistics created?", the APA manual ensures that the researcher is actively addressing these three questions in a straightforward and transparent manner. The methods, results, and discussion sections allow others to evaluate the research because it is clear where and how the information was collected directly and where information was missing and

under what conditions; no guessing. This is consistent with 'good statistics' as defined by Best (2001b).

In AR #9, students demonstrated an understanding of the issues involved with generalizing from research conducted on a culturally homogenous sample in a controlled laboratory setting to a broader population. One student wrote:

Most research conducted on college students are on students that are still very young (freshman and sophomores) and they possess the characteristics of late adolescence. Generalizing from just a sample of college students will be a bias toward the general public. Research on a culturally homogeneous sample will give us results that cannot be generalized across cultural groups. Conducting research in a laboratory setting raises the question of whether the finds from an experiment can be generalizable to real-life settings since research conducted in a laboratory is under highly controlled conditions.

Finally, in AR #14, the students had to consider how the statistics they had learned in the course should be applied back to research. One student answered:

Cohen advocates for using statistics descriptively, for planning research (size of effect, alpha level, power level, sample size), for measure of effect size, for providing confidence intervals, and in conjunction with informed judgement as a scientist.

The STAT assignments were also used to assess these two sub-objectives. STAT #1 asked student to identify a population and representative sample in their own field, then to: *Describe one potential problem with the population in part c. that could make getting a truly representative sample difficult.* One student wrote:

Truly representative sample would consist of sample selected from all 190 different participating countries. If the students in other countries do not respond to the survey then the study will not have true representation from the real population.

For STAT #11, the students had to find an article from their own field that used a t statistic to test a statistical hypothesis, then determine the type of t statistic used (one-sample, two-sample independent measures, or two-sample repeated measures), the null and alternative hypothesis tested, determine whether an effect size measure was reported, and discuss whether there was any additional information that the author could have provided that would have made it easier to determine whether the t test had been carried out appropriately. For the last piece of this question, one student responded:

I wish the author would have discussed if the critical value of t was directional (one-tailed) or not (two-tailed). I also wish the author would have included an effect size to show if the difference in the two means (male/female) was large compared to the square root of the pooled variance (Pooled standard deviation).

Learning Objective #2

The second main course objective is that after the course: ***the students know which statistics are appropriate for different types of data and/or studies***. The two sub-objectives necessary to achieve this main objective are: *students understand what makes a specific statistic appropriate for a specific study or set of data* and *students understand the assumptions that accompany a specific statistical method*. These two sub-objectives were achieved/assessed jointly by the AR and STAT assignments.

Students demonstrated an understanding of probability, a fundamental component of inferential statistics, on AR #7 by distinguishing between the actual probability and the perceived probability of flipping a coin ten times and getting the sequence *HHHHHHHHHH* versus *HTHTHTHTHT* about which one student responded:

[HHHHHHHHHH] seems way more surprising than [HTHTHTHTHT] though the probabilities are the same. Based on the article though, surprise is different from actual probability. We often feel the need to explain 'strange' situations that happen, so we find connections and relationships, when really, that may actually just happen. We need an excuse or reason for the situations that happen, so we say that they are coincidence. This 'surprise' is very different from the actual probability that with as many people as there are in the world, things are likely to happen.

AR #8 asked *What is the gambler's fallacy?*, for which student Eric Holley wrote:

The gambler's fallacy is the idea that a series of observations will reflect the true proportion in a chance experiment. For example, if you flipped 20 coins you would expect 10 heads and 10 tails. If you flipped 13 of those 20 coins and got 10 heads, you would expect the majority of the remaining coin flips to be tails in order to retain the expected probability of chance. However, this fallacy is a misconception that any deviation in one direction will be corrected by a deviation in the other which may or (more likely) may not be the case.

AR #10 required students to understand the shortcomings of null hypothesis significance testing (NHST), specifically *p*-values, discuss recommendations to avoid these problems, and consider a journal that recently banned the use of all NHST, requiring the reporting of effect size measures only, to which one student wrote:

I don't think [NHSTs] should be banned because of their misuse. Effect size helps readers understand the magnitude or level of differences found in a research; statistical significance examines whether the findings are likely to be due to chance. Both are essential for readers to understand the full impact of research work.

AR #11 discussed the origin of the .05 Type I error rate commonly used by researchers and asked *Do you believe everyone should use .05? Why or why not?* One student replied:

I think each researcher conducting a study needs to set their own level of significance and report it in the findings. For example, manufacturing and testing of precision instruments would differ from a psychometric test on humans. It comes down to the researcher identifying a level of significance they are comfortable with.

In AR #13, the students had to demonstrate an understanding of why causation cannot be inferred from correlation, for which one student wrote:

The first pitfall of trying to deduce causation from correlation is that a correlation might be spurious. The second pitfall of trying to deduce causation from correlation is that a correlation might be due to measurement error.

The STAT assignments were also used to assess/achieve these sub-objectives. In STAT #2, the students were required to give examples of interpolation and extrapolation from their own field, for which one student answered:

Extrapolation = If I had the High School Reading Demonstration Exam passing rates for students who identified with specific learning disabilities for 2001-2004, I could extrapolate the passing rate for students identified with specific learning disabilities for 2005. Interpolation = If I had the High School Writing Demonstration Exam passing rates for junior in 2010 and 2012, I could interpolate the passing rate for juniors in 2011.

STAT #3 asked *[I]s the mean or median a more accurate measure of central tendency and why?* Student Ethan Hill wrote:

It depends on the situation. When the data are skewed, positive or negative, the extreme scores affect the mean in such a way that the mean no longer reflects the data as a whole. In such a scenario, the median may be more beneficial. When the data distribution forms more of a normal bell curve, the mean would be most ideal as it considers all scores, not just the middle score.

In STAT #4, the students were asked *Why do we subtract 1 from the sample size when computing the variance in the sample?*, to which one student responded:

When we know the mean all values are free to vary except for one value. This means that one observation is not allowed to freely vary and is called losing a degree of freedom. When this occurs, we use the $n-1$ to account for subtracting one observation

from the total. If we don't account for that loss of a degree of freedom out [sic] sample estimates will be biased.

STAT #7 required the student to give an example from their own field that illustrated the meaning of sampling error. One student answered:

Let's consider a population of all adult immigrant English language learners of Nebraska aged between 35 and more, and I want to know their average level in the target language, I can consider a sample size of 50 from this population for example; the average mean I will get from the sample will not and could not be exactly the same as the average mean of the population; and if I take different samples, the means are likely not to be the same within samples neither, because some immigrants may have an English background that will favor them compared to others who do not. This could be considered as a discrepancy or a sampling error.

And STAT #8 asked the student to give an example of a Type I and a Type II error in their own field. One student wrote:

In the field of education, a possible type 1 error may occur when a reading intervention program is used in classroom showing that it had an impact on student test scores. However, the reading intervention did not actually impact the test scores. [A] type II error would occur if the new curriculum did in fact have a positive affect on student learning, but the researcher failed to reject the null hypothesis, which would state that the treatment had no affect on the students' learning.

In STAT #10, the student was asked *What happens to the t statistic if the assumption of homogeneity is violated?* and one student said:

If you violate homogeneity then it will most likely result in an over estimation of the t test by under estimating the error. This will reject the null that is actually true, causing a type I error.

Learning Objective #3

The third main course objective is that after the course: ***the students are able to run statistics on real data***. The two sub-objectives necessary to achieve this main objective are: *students are able to generate specific statistics by hand and using statistical software* and *students are able to interpret statistics and identify the relevant information in the output from a statistical software package*. These two sub-objectives were primarily achieved/assessed through the STAT assignments.

Each of the fifteen STAT assignments required the students to take a small data set, compute the appropriate statistic(s) by hand, answer questions related to the statistics they computed, and then use the SPSS statistical software program to compute the same statistics, allowing the students to check their hand calculations. For example, for STAT #9, which covered the one-sample t test, students were given a data set consisting of fourteen cases and two variables: the weight and circumference of heirloom tomatoes. The students were required to use these data to test whether or not reducing the amount of fertilizer significantly decreased the weight or circumference of the tomatoes. By hand the students:

- a.) Stated the null and alternative hypotheses for weight for a one-sample t test.
- b.) Found the critical t value needed to test the hypotheses using a table of critical t values.
- c.) Computed the one-sample t statistic for weight.
- d.) Used the one-sample t statistic and critical value to make a decision about their null hypothesis and identify what type of error they could be making in their decision.
- e.) Computed the 95% confidence interval around the mean weight and use the confidence interval to also test for significance.
- f.) Computed the Cohen's d effect size measure and interpret the size of the effect.
- g.) Computed the r^2 effect size measure and interpret the size of the effect.
- h.) Interpreted the results to determine whether reducing the amount of fertilizer had an effect on the weight of the tomatoes.

Then the students had to compute the one-sample t statistic and 95% confidence interval for weight using SPSS and identify the relevant information in the output.

By completing the STAT assignments, the students demonstrated their ability to generate specific statistics by hand and computer, as well as interpret the resulting statistics and apply the results back to the original data, for each of the topics covered in the class:

- 1.) Populations and Samples
- 2.) Frequency Distributions
- 3.) Central Tendency
- 4.) Variability
- 5.) z -Scores

- 6.) Probability
- 7.) Distribution of Sample Means
- 8.) Hypothesis Testing/ z Statistic
- 9.) One-Sample t Statistic
- 10.) Two-Sample Independent Measures t Statistic
- 11.) Two-Sample Repeated Measures t Statistic
- 12.) One-Factor Independent Measures ANOVA
- 13.) One-Factor Repeated Measures ANOVA
- 14.) Two-Factor Independent Measures ANOVA
- 15.) Correlation
- 16.) One- and Two-Predictor Multiple Regression

Learning Objective #4

The fourth main course objective is that after the course: ***the students understand the importance of statistics in research***. The two sub-objectives necessary to achieve this main objective are: *students understand the integral role of statistics in research* and *students have developed the self-efficacy to continue to improve their training in statistics*. These two sub-objectives were achieved/assessed primarily through the AR assignments. The students demonstrated that they had learned about the role of statistics in research in a variety of ways.

For AR #1 the students were asked *In your own words, why is methodology important?*, to which one student replied:

Methodology is important because it explains why you want to do research in a certain way. It helps others to know what you are doing and it creates consistency and can help others to pinpoint potential error. If a study were to be recreated, methodology is important because it keeps research rigorous.

The students were then asked *[W]hat is the purpose of statistics?*; student Eric Holley wrote:

Statistics is a method to extract information from data in order to understand the details of the situations that the data portray. In terms of scientific knowledge and methodology this allows scientists and observers to collect data and observations from a certain set of variables, even when not present in the situation, and infer meaning based on those data.

The students also demonstrated an understanding of the need for and general lack of training in *statistical literacy* that exists in many academic programs. To the question from AR #5 *What is statistical literacy and why is it important?*, a student responded:

Statistical literacy is the set of basic skills for being able to critically interpret the statistics we encounter in daily life and to resist bad statistics. It is important because the newspapers, articles on the Internet, etc. often present numbers or statistical information and readers need to be able to evaluate statistical material in their daily lives. It is important that people question claims by scientists, politicians or activists and may be considered to be a fundamental to being an informed citizen.

AR #6 required the students to think about the number of methodology courses required for their current degree compared to the average number of methodology courses actually taken by students in their field. They also had to examine a number of minors and certificates in

methodology offered by UNL and identify which minor/certificate was most relevant to their degree and why. Student Ethan Hill responded:

Of the listed minors or certificates, I would prefer to take the “Mixed Methods Research”. These courses, first, are most similar to the courses I already have to take. Secondly, the courses seem relevant and interesting to my field.

AR #12 introduced the students to the history of statistics, specifically that many of the statistical techniques being learned in the class were developed to address very specific real-world research issues. When asked *Fisher is credited with developing ANOVA. What real world issue required the development of ANOVA?*, one student wrote:

Fisher developed ANOVA in response to trying to determine the effects of different fertilizer mixes on different varieties of potatoes. Agricultural scientists knew some parts of fields were better than others – some plants were tall and yielded much, some plants were thin and scraggly – but were unsure why. Could be water drainage, changes in soil type, presence of unknown nutrients, blocks of perennial weeds, or some unknown or unforeseen effect. So, they compared 3 types of fertilizer, 10 varieties of potatoes, and 4 blocks of soil.

The sub-objective of increasing self-efficacy was not formally evaluated, but anecdotally several students indicated that they were no longer as afraid of statistics as they were before they took the class. Many students came to discuss with me which additional method courses I believed they should take next. And finally, several students indicated that they planned to sign up for one of the methods minors or certificates that were discussed in class.

Reflections

Overall, I believe the revised EDPS 859 course was a success. Re-evaluating (or more accurately evaluating for the first time) the course objectives and using backwards design to achieve these objectives forced me to pay more attention to the objectives I really wanted to address in the course and to think critically about how the structure of the course needed to be changed to achieve these objectives. Adding the additional readings allowed me to provide a context for the rest of the course material that I always found lacking in previous course offerings. In fact, I would routinely be very irritated by the end of the course as the students seemed to never be able to have a conversation about statistics at the level I expected. This time around, this was not an issue. Increasing the amount of time the students actually calculated and interpreted statistics by increasing the number of STAT assignments from eight to sixteen, while eliminating the exams, also allowed for more time to discuss topics of interest and reduced the stress level of the students an incredible amount. This is the first time in EDPS 859 that the students have not only been engaged in the conversation, but actually lead the conversation in new directions by asking questions. In general, I am very happy with the way the course turned out and hope to not only build on this success for EDPS 859 by revising the course based on this benchmark portfolio, but also to incorporate what I have learned here into my other statistics courses.

What Worked

The removal of the exams seemed to be a resounding success on all sides. I appreciated the increased flexibility that occurred in my teaching when I was not constrained by teaching towards the content of the exams and the ability to spend more time on a specific topic or more fully follow a tangent topic because I did not have to have specific material covered before an exam. The students responded very favorably to not having exams as well and seemed much more relaxed and willing to ask questions during class. They were made aware that the lack of exams was being counterbalanced by an increased number of assignments (both STAT and AR), so the overall amount of work in the class was actually higher than when there were three exams, but they seemed to embrace the extra work, as long as it was not called an exam.

The other resounding success was the inclusion of the additional readings. These students ended the class with a much better understanding of the role of statistics in research, which in turn made the case for why this was a required course for most of them. It also made the case for continuing their methodological training beyond this one, very introductory course. The AR assignments provided a platform to discuss topics that otherwise would have been left out of the course and served to generate some very interesting and important discussion questions that lead to a better understanding of the material.

What Needs to Reworked

Though in general the students had a favorable perception of the assignments, the number and spacing of the assignments was an issue. First, sixteen AR assignments were too many as there really are only fourteen weeks during the semester, so the next time I teach the class I will only plan on fourteen. Second, the STAT assignments got bunched up and then were spread too far apart because I did not want to assign the STAT assignments until after we covered a chapter, but I also wanted to give the students adequate time to complete the assignments. This led to a considerable amount of confusion for myself and the students about when a specific STAT assignment was due. Next time I teach the class, I will make the STAT assignments more like the AR assignments with one assigned each week, due the following week. I also need to take a look at the content of the STAT assignments to be sure that they are not too long if the students only have one week to complete them.

The other main issue that needs to be reconsidered for the next time I offer this course is the grading. Thirteen of fourteen students received an A in the course. Though I believe the students earned their grades, there was not as much grade differentiation between students as I would have liked. That is, I do not necessarily believe all of the students had mastered the material to the same extent, so restructuring the grading may be necessary to better differentiate between students. I also need to reconsider how many assignments may be dropped and when so that more students turn in the later assignments (AR #13 and #14, and STAT #14 and #15) rather than simply checking out for the last two weeks of the course because they are happy with their grades on the previous assignments.

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Appendix

COURSE SYLLABUS

EDPS 859 – Section 001 (CID 038175)—Statistical Methods—Spring 2015

Tuesday/Thursday 3:30pm-4:45pm Jorgensen Hall 151

Instructor:	Matt Fritz, PhD	TA:	Wei Wang
Office:	31 Teachers College Hall		
Office Phone:	472-4033		
E-Mail:	matt.fritz@unl.edu	wangwei.apply@gmail.com	
Office Hours:	Wednesday 2-4pm <u>or</u> by appointment	TBD	

What are statistics?

“The word *statistics* came into English from Latin and German and ultimately derives from the same Indo-European root that gave us *standing*, *status*, *state*, and even *understand*. In the minds of most people, *statistics*... mean[s] roughly, a description of “how things are.” It is true that a part of the theory of statistics concerns effective ways of summarizing and communicating masses of information that describe a situation... known as *descriptive statistics*. Although descriptive statistics forms an important basis for dealing with data, a major part of the theory of statistics is concerned with another question: How does one go beyond a given set of data and make general statements about the large body of potential observations, of which the data collected represent but a sample? This is the theory of *inferential statistics*.” Hays (1994; p. 1)

Course Objectives:

1.) *Become critical consumers of statistics in published research and the popular press.*

Whether you are planning to take more statistics courses and conduct your own research or not, after this course you should be able to read a journal or newspaper article that contains one or more of the basic statistical techniques discussed in the course and both understand the meaning of the statistics presented as well as potential pitfalls that accompany using these statistics. This means you will need to be able to correctly interpret reported statistics and identify potential problems that accompany using a specific statistical technique.

2.) *Know which statistics are appropriate for different types of data and/or studies.*

In order to be critical consumers or producers of statistics, you need a more general knowledge of various statistical techniques and the assumptions behind each technique. This means you need to understand what makes a specific statistic appropriate for a specific study or data set and understand the assumptions that accompany a specific statistical method.

3.) *Be able to run statistics on real data.*

In addition to being a critical consumer, you should also be able to produce basic statistics, which means that you need to be able to use at least one statistical software package to generate statistics on a data set and be able to identify the statistics that are produced in the output from the statistical software package. In addition, you should understand that statistical software packages are just tools to generate statistics, nothing more. Therefore, the particular software used is irrelevant, provided the correct statistics can be computed.

4.) *Understand the importance of statistics in research.*

Statistics are an important tool for researchers. Each additional methodology course you take, quantitative or qualitative, represents one more tool you have to conduct research because each additional technique you learn allows you to ask and answer theoretical questions in new ways. This means that you will need to understand the integral role of statistics in research and develop the self-efficacy to continue your training in statistics if you choose to do so.

Prerequisites: College algebra or equivalent.

Text:

Required: Gravetter, F. J., & Wallnau, L. B. (2013). *Statistics for the behavioral sciences* (9th ed.). Belmont, CA: Wadsworth. (ISBN: 978-1-111-83099-1)

Note Earlier/international versions of the Gravetter and Wallnau book contain essentially the same information. However, the page numbers, chapter numbers, and directions for using SPSS may have changed. If a different version of the book is purchased, it is the student's responsibility to find the correct information.

Supplemental: Field, A. (2013). *Discovering statistics using IBM SPSS Statistics* (4th ed.). Los Angeles, CA: Sage. (ISBN: 978-1-4462-4918-5)

Course Requirements:

Statistical Homework Assignments: There will be 16 homework assignments, one for each topic we cover throughout the semester, which will require hand calculations and the use of the statistical software package SPSS to compute the statistics we discussed in class on a small data set, and answering questions based on the hand calculations and output. Students are allowed to work in small groups of up to three on the statistical homework assignments. Each statistical homework assignment will be worth a total 20 points. The lowest two statistical homework

assignments grades will be dropped, which means that any two of the statistical homework assignments do not have to be turned in at all. If all 16 statistical homework assignments are turned in and a score of 12 or higher is received on each assignment, an additional 10 bonus points will be given.

Additional Reading Assignments: There will be 16 additional reading assignments throughout the semester. These assignments will require the student to answer questions about an additional reading (either provided by the instructor or found by the student) that is related to the course. Students are allowed to work in small groups of up to three on the additional reading homework assignments. Each additional reading assignment will be worth 5 points. The lowest two additional reading assignment grades will be dropped, which means that any two of the additional reading assignments do not have to be turned in at all. If all 16 additional reading assignments are turned in and a score of 2 or higher is received on each assignment, an additional 5 bonus points will be given.

Final Grade: Each student's final grade will be determined by summing the points earned on the 14 highest statistical homework and additional reading assignments, then dividing by 350 [= 14*(20+5)] to compute the overall percentage for the course. Grades will then be assigned as follows:

A	93% - 100%
A-	90% - 92.99%
B+	87% - 89.99%
B	83% - 86.99%
B-	80% - 82.99%
C+	77% - 79.99%
C	73% - 76.99%
C-	70% - 72.99%
D	60% - 69.99%
F	0% - 59.99%

Blackboard:

This course will use Blackboard extensively for posting lectures, handouts, and assignments. All students are expected to have access to the course's Blackboard site no later than the beginning of the second class meeting. It is the student's responsibility to make sure they have access.

Statistical Software:

As stated above, we will be using SPSS a great deal during this course. SPSS is a statistical software package that is available for both PCs and Macs. I do not expect students to have any prior experience with SPSS, but it is the student's responsibility to make sure they have access to a functioning copy of SPSS.

Availability: Note that SPSS is available in the ALTC computer lab in Mabel Lee 163, in other computer labs on campus, and is currently available for purchase from the UNL Computer Store for \$69.

Technology Policy:

The use of laptop computers and tablets for following along with lectures and note taking is permitted during lectures. The instructor reserves the right to revoke this permission on a case-by-case basis if these devices are used for non-class related activities (Facebook, Twitter, e-mail, work for another class, etc.) that is disruptive to other students. The use of cell phones is not permitted at any time.

Academic Dishonesty:

Academic honesty is essential to the existence and integrity of an academic institution. The responsibility for maintaining that integrity is shared by all members of the academic community. To further serve this end, the University supports a Student Code of Conduct (<http://stuafs.unl.edu/ja/code/three.shtml>) which addresses the issue of academic dishonesty. Any and all issues of academic dishonesty will be referred to the university.

Diversity:

The University of Nebraska-Lincoln is committed to a pluralistic campus community through Affirmative Action and Equal Opportunity. In order to foster an open and comfortable learning environment, this class will follow the Diversity Policy at UNL: http://stuafs.unl.edu/sa_policies_diversity.shtml

Services for Students with Disabilities:

Students with disabilities are encouraged to contact the instructor or teaching assistant for a confidential discussion of their individual needs for academic accommodation. It is the policy of the University of Nebraska-Lincoln to provide flexible and individualized accommodations to students with documented disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students must be

registered with the Services for Students with Disabilities (SSD) office (<http://www.unl.edu/ssd/>), 132 Canfield Administration, 472-3787 voice or TTY.

Hays, W. L. (1994). *Statistics* (5th ed.). Forth Worth, TX: Harcourt Brace College Publishers.

List of Topics

<u>Chapter</u>	<u>Topic</u>
-	Syllabus and course introduction
1	Introduction to statistics
2	Frequency distributions
3	Central tendency
4	Variability
5	z -scores: Location of scores and standardized distributions
6	Probability
7	Probability and samples: The distribution of sample means
8	Introduction to hypothesis testing
9	Introduction to t statistics
10	The t -test for two independent samples
11	The t -test for two related samples
12	Introduction to analysis of variance
13	Repeated measures analysis of variance
14	Two-factor analysis of variance
15	Correlation
16	Introduction to regression
17	Chi-square (Time Permitting)

Ticket Out of Class

1.) For me, the material in this class is being covered:

Too Slowly

Just Right

Too Fast

2.) I believe that for the other students in the class (not including myself) the material in this class is being covered:

Too Slowly

Just Right

Too Fast

3.) The thing I dislike the most about this class is:

4.) The thing I like best about this class is:

5.) If I could change one thing about this class it would be:

6.) What could I do personally to make this class better for me?

Statistical Assignment #9—EDPS 859—Statistical Methods (Spring 2015 – Fritz)

Date Assigned: March 10, 2015

Date Due: March 19, 2015 at the beginning of class

Feel free to discuss this assignment with other students in the class, but please answer the written questions on your own. You may work in groups of two or three on the computer portion of this assignment if you wish (if you choose this option, please indicate who you worked with), but each student must turn in a separate copy of the written answers and all computer print outs.

PART I. Short Answer: None.

PART II. Hand Calculations:

The data for this homework consists of 14 cases and 2 variables:

Weight: The weight in pounds of an heirloom tomato

Circumf: The circumference in inches of an heirloom tomato

The data are posted on Blackboard in the file Stat_HW_9_data.sav. Note: The data for this assignment are made up.

Given the increased price of fertilizer, an heirloom tomato farmer is looking for ways to cut production costs. One possible solution is to reduce the amount of fertilizer that is applied to the heirloom tomato plants. The farmer wants to know if only applying half of the normal amount of fertilizer will change the weight or circumference of the heirloom tomatoes. The farmer decides to investigate this by only giving one half the normal amount of fertilizer to $n = 14$ heirloom tomato plants for six weeks and then weighing and measuring the largest tomato on each plant. The farmer knows that the mean weight of the heirloom tomatoes receiving the full amount of fertilizer is $\mu = 2.00$ pounds and the circumference is $\mu = 7.00$ inches. They do not know the value of σ for either weight or circumference.

1.) Given the description above, what are the farmer's null and alternative hypotheses for the effect of halving the fertilizer on the weight of the tomatoes? Be specific and use correct notation.

- 2.) Using an alpha level of .05 and the t Table on page 703 of the book, what are the critical values for the null and alternative hypotheses in #1?
- 3.) Compute the one sample t -test for the effect of fertilizer on weight. Show your work. You may use SPSS to find the mean, variance, and standard deviation, but not the standard error or the t statistic.
- 4.) Based on the critical values in #2 and the t statistic in #3, should you fail to reject or reject the null hypothesis?
- b.) Based on your decision in part a., what type of error could you be making?
- 5a.) Using the critical values in #2 and the standard error in #3, compute a 95% confidence interval around the mean weight.
- b.) Based on only the confidence interval in part a., should you fail to reject or reject the null hypothesis? Explain your answer. (Hint: This is not the confidence interval around the difference in means, so you will need to think about the null hypothesis and what it means when you consider what value is inside or not inside the confidence interval around the mean.)
- 6.) Compute Cohen's d for weight.
- 7.) Compute the percentage of variance explained for weight.
- 8.) Repeat questions 1, 3, 4, 6, and 7 for circumference.
- 9.) Based on your answers to 1-8, what do you conclude regarding the effect of halving the fertilizer as a way to cut production costs?

PART III. SPSS Calculations:

Use SPSS for Questions 10 and 11.

- 10a.) Using SPSS, compute the one sample t -test for the effect of fertilizer on weight, including the 95% confidence intervals. Do these values equal the values you computed by hand? Why or why not?
- b.) What is the exact probability of observing the t statistic in #3?

11a.) Using SPSS, compute the one sample t -test for the effect of fertilizer on circumference, including the 95% confidence intervals.

b.) What is the exact probability of observing the t statistic in #8?

NOTE: Each person MUST turn in a printed copy of their SPSS output. Please do not write your answers on the computer output. And please only turn in the final correct copy of the output.

Additional Reading Assignment #6—EDPS 859—Statistical Methods (Spring 2015 – Fritz)

Date Assigned: February 19, 2015

Date Due: February 26, 2015 at the beginning of class

Feel free to discuss this assignment with other students in the class, but please answer the written questions on your own. You may work in groups of two or three on this assignment if you wish (if you choose this option, please indicate who you worked with), but each student must turn in a separate copy of the written answers.

Additional Readings:

Aiken, L. S., West, S. G., & Millsap, R. E. (2008). Doctoral training in statistics, measurement, and methodology in psychology. *American Psychologist*, *63*, 32-50.

Questions:

Please answer the following questions based on the additional reading, keeping each answer to a paragraph or less (i.e., 1/2 of a page or less), unless otherwise instructed.

- 1.) What are the statistics/methods course requirements for the degree you are currently pursuing? Please list these courses including department, course number, and title/topic.
- 2.) Regardless of your answer to #1, how many statistics/methods courses, including qualitative courses, does the average student in your degree program take while at UNL? Please list these courses including department, course number, and title/topic.
- 3.) Based upon the information from Aiken, West, and Millsap (2008), what do you think is the bigger problem with quantitative training in psychology (and by extension the rest of the social and behavioral sciences): not enough quantitative psychologists or substantive psychologists not receiving enough quantitative training? Why?
- 4.) Regardless of your answer to Question #3, give one possible solution to increasing the quality of the quantitative/methods training for your field.
- 5.) There are numerous minors (at both the masters and doctoral level) and certificates in methods offered at UNL. For example, Educational Psychology offers two minors, one in Statistics/Measurement and one in Quantitative & Qualitative Methods (<http://cehs.unl.edu/edpsych/minors/>), and a certificate in Mixed Methods (http://www.unl.edu/gradstudies/prospective/programs/Cert_MixedMethodsResearch). In addition, the Survey Research and Methodology Program (SRaM) offers a minor and a certificate (<http://sram.unl.edu/prospectiveandcurrentstudents/acads.asp>). Look at the requirements for all five of these minors/certificates and indicate which looks the most relevant/interesting to you and why.