2021

A Peer Review of Teaching Portfolio — STAT 822: Statistical Methods II

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Abstract

The peer review of teaching program gave me the opportunity to reflect on my teaching in terms of pedagogical goals and methods for the course Stat 822: Statistical Methods II which is offered to MS level students in the Department of Statistics. Even though the course is part of the list of required courses for MS students in the department, typically about a third of the students are from other departments. The portfolio describes details about how the course fits into the MS program in the Department of Statistics, the context of the course, the learning objectives, expectations from students, the teaching methods, and the outcomes after teaching the course. Writing this portfolio enabled me to improve how I teach Stat 822, how I chose and organize the contents in the course, what types of exercises and assessment I employ that maximizes the learning outcome.

Keywords: Statistics, methods, MS, portfolio

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1. Introduction and Objectives of Peer Review of Teaching Portfolio

I enrolled in the peer review of teaching program in the academic year of Fall 2020-Spring 2021 because I had several goals that I wanted to accomplish. I wanted to improve my teaching in general, and this was the second time I was teaching the Stat 821/Stat 822 (Statistical Methods I and II) sequence in the Department of Statistics. In the spring I was teaching Stat 822, which is the focus of this portfolio. This course is very important to our department, and there were several discussions among the faculty about the materials presented in the Stat 821-822-823 series because it seems like we are covering a lot of material that we might consider as prerequisites of the course. However, our department admits several students who need a certain level of background before diving into more complex concepts.

The creation of the portfolio gives me the opportunity to document the course in terms of context of the course, the learning objectives, expectations from students, the teaching methods and strategies used to effectively teach all of the concepts that are on the syllabus, and the outcomes after teaching the course. One of my questions I wanted to find answer for is whether there are parts of the course content that can be reduced or eliminated compared to teaching it in the previous year.

Finally, I feel passionate about teaching students and deliver the material in a way that students can apply it in the future. I am hoping to find a way to evaluate whether my strategies are working, and students develop the required skills.

2. Course Description

Statistics 822: "Statistical Methods II: Advanced Modeling – Methodology, Philosophy and Supporting Theory" is a course that is the second of a three-semester sequence that forms the core curriculum in the theory and application of statistical methods for a Master of Science degree in Statistics. It is intended for graduate students majoring in Statistics or minoring in Statistics. Students have to have sufficient background in basics Statistics, matrix algebra, probability and mathematical statistics. Specifically, students must have taken (and passed) the probability and mathematical statistics sequence (Stat 882 and 883 or equivalent) or be concurrently taking the Stat 882/883 sequence in order to take this course. Also, students must have taken the first course of the three-semester sequence (Stat 821).

Usually around 2/3 of the students are graduate students in the Department of Statistics, and 1/3 of the students (masters or PhD) come from other departments within IANR. The course is an important milestone for students who want to become masters level statisticians and who are planning to take the written comprehensive exam in the Department of Statistics to become PhD students.

3. Course Goals

Contemporary statistical methods involve a combination of design and planning (what goes on before and during the time data are collected), statistical modeling (how, from a mathematical and probability point of view, do we account for variation in the data, and how are the data to be analyzed), modeling theory (what is the conceptual basis for the methodology we use and what is its theoretical justification) and general knowledge of statistical inference and communication (how do we interpret and report the results of an analysis). Statistics is in a period of rapid development and rethinking of classical ideas. As a result, master's level statisticians need to develop these skills to be marketable.

This course builds onto the foundation that student developed in the first semester of this sequence (Stat 821). Stat 821 focused in statistical methods with single response variable that is normally distributed. In this course, we developed the methodological foundation of linear models and experimental design. Also, we touched on the use of mixed models (where fixed and random effects are included into the model) but we didn't have the opportunity to develop the theoretical framework. However, in a master's level core-course that focuses on statistical methods it is important that students also understand the methodological and theoretical background, and they don't only focus on how to use a software to analyze data.

In Stat 822 we start the semester by connecting Stat 821 and Stat 822, and we focus on mixed models and the underlying theory. In this section of the course the goal is for students to connect models with random and without random effects. Also, this is important for the rest of the semester because most of the models we focus on also have random effects.

In Stat 822 one other overarching goal is to prepare students to be able to analyze data where the response does not have a normal (Gaussian) distribution. This requires additional model development, and the understanding of how to determine the correct distribution to use. After learning about the so called generalized linear models (models with non-Gaussian response and only fixed effects) and generalized mixed linear models (models with non-Gaussian response and with fixed and random effects), students should be able to identify which linear model they should be utilizing for a given data set, they should be able to analyze the data, use a software package to analyze the data and interpret the results. One of the skills that they should develop is how to connect with researchers who are not familiar with these models. Their goal is to be able to ask the correct questions from the researchers to be able to analyze the data correctly and interpret the results in a way that researchers can also understand, and the interpretations are useful for responding to the original hypotheses.

In Statistics there are two major branches: frequentist statistics and Bayesian statistics. Most undergraduate and graduate courses focus on frequentist approaches and it is the same for Stat 821 and Stat 822. The ultimate difference between these two approaches lay in how probability is interpreted, and the Bayesian inference relies on some prior knowledge. Bayesian

statistics is an important field, and it is important to at least expose students to this way of thinking. Students should learn the basics of Bayesian statistics and how to perform some analysis using the fundamental concepts in Bayesian statistics. Even though Bayesian statistics is not a focus of Stat 822, I also introduce the basic concepts of Bayesian analysis to students.

I want students to be able to synthetize all of the models, methods, concepts that we learn in both of the courses (Stat 821 and Stat 822) and be able to decide on a model that is optimal for a given situation and problem. I also want students to develop skills to become critical thinkers and be able to identify reasons for their chosen methods. The goal is not only that students should be able to analyze data with the methods that they learned and utilize the models but also be able to modify these and come up with similar models that fit their data better.

4. Rationale for Course Selection

Stat 822 is an important course in our department because it is a core-course for MS students. Students who are not successful in this class are not able to graduate with an MS degree and they are not able to even try to take our written comprehensive exam to become PhD students.

I started teaching Stat 822 last year (Spring of 2020) when one of the faculty members who was teaching it for a long time decided to retire. Before I first instructed the class, I observed his teaching, and he mentored me when I prepared for teaching it. When I was sitting in his lectures I had an opportunity to not only observe the material but also his teaching style. The first time I was teaching the course I used a lot of his methods to explain concepts. I significantly re-arranged the order in which I was teaching the material, but I wanted to try to change how I present the material and try to improve the class.

5. Teaching Methods, Course Materials

Stat 822: Statistical Methods II were thought in person during the spring semester of 2021. Due to the COVID situation I also recorded the lectures and upon request students were able to join the class via zoom. There were eight students in the class, and only one student requested the zoom option for a longer period of time (for a little over a month), and two additional students showed interest in occasional recordings. Thus, I can conclude that the class was taught in person with the assistance of zoom.

The small class size enabled me to instruct the class very close to a “normal” setting where students had frequent group discussions, and group assignments. Statistics 822 (Statistical Methods II) strictly builds on the material presented in Stat 821, and the requirements are very similar to the requirements presented in Stat 821. Students are not surprised of the high-paced classes with constant work in the background (students were either working on a homework assignment or an extra reading assignment which they were tested on). The classes were

scheduled to meet for 75 minutes on Mondays, Wednesdays and Fridays (instead of the normal 50-minute lectures for a three-credit course), and I used all of the 75 minutes to make sure I provide the best I can to the students.

Students had four announced quizzes throughout the semester, eight homework assignments, two in-person paper-based midterm exams, and a take-home final exam.

I changed the structure of the semester compared to last year in terms of how the exams were conducted and how some assignments were distributed. Last year, I had to change the class in a very short notice (due to the COVID-19 pandemic situation) and had to teach via zoom. Students were struggling with the situation, so I decided to reduce the number of exams to two from the originally planned three exams. Students also fewer homework assignments (seven) and fewer announced quizzes (three) last year.

This spring semester I was fortunate to implement the teaching methods I was originally planning to do. At the beginning of the semester, I was not sure whether I should give one in-person and two take home exams to the students, or two in-person and one take home exam. I think it was a good decision that only the final exam was take home. I feel having one take home exam in this class is crucial because students need to have real-life problems where they are able to analyze a data set with some complications. However, it requires more time than a traditional 90-minute exam. Also, I wanted to make sure that students are exposed to real PhD qualifying exam questions so several of the final exam questions were either PhD qualifier exams from the past or exam questions that could have been PhD qualifier exam questions.

6. Some Specific Course Activities

During the semester students had several class activities where they worked together on problems. As I mentioned before I also wanted to emphasize critical thinking in this class. There was an occasion when I asked students to come up with a solution to a problem for which we didn't discuss the methods yet. This problem was in the area of mixed models and best linear unbiased prediction. A following scenario was given (taken from Dr. Dan Nettleton's Stat 510 notes at Iowa State University) without discussing any additional example or model formulation:

Example

Suppose intelligence quotients for a population of students are normally distributed with a mean μ and variance σ_u^2*. Suppose an IQ test was given to an i.i.d. sample of such students. Suppose that, given the IQ of a student, the test score for that student is normally distributed with a mean equal to the student's IQ and a variance* σ_e^2 *and is independent of the test score of any other student. Suppose it is known that* $\sigma_u^2/\sigma_e^2 = 9$*. If the sample mean of the*

students' test scores was 100, what is the best prediction of the IQ of a student who scored 130 on the test?

First, I gave students the opportunity to think about the problem alone without giving them any guidance. I was happy to see that even though students were not getting the correct answer (because at this point, we didn't discuss the model formulation or how to actually start a problem like the one presented), but about half of the students presented some type of an idea how to solve the problem.

Then, I presented the theory that is needed to solve this problem, and I asked students to re-think their answers at home. Next time when we met, I briefly asked their answers and gave them the opportunity to have a discussion in groups. I feel that by the time they discussed the problem in groups they had a good understanding how to proceed but the group discussion was really necessary for most of the students.

Another specific class activity arose after I graded the second exam which was an in-person exam. I noticed that there was a specific problem where students struggled. I felt this particular problem was too important to ignore or to not emphasize enough. Because of that I decided to not post the solution to this problem but to ask students to think about it again. I gave them the opportunity to discuss it in groups and then as a mini homework assignment they had to provide a detailed solution for the following class. This particular problem involved proving a mathematical statement, so I told them that they have to explain every single step. For the original exam only two students (out of the eight) received full credit for this problem, but after this group exercise and mini homework assignment all of the eight students proved to have a good understanding of the problem.

7. Analysis of Student Learning

In Stat 822 it is difficult to evaluate students' learning because the number of students is very small. In the spring of 2020, there were seven students enrolled, and in the spring of 2021, there were eight students enrolled. The grade distribution was very similar in the two classes (data are not presented due to the small sample size, thus it could be easy to identify specific students even by just looking at the summary statistics).

My goal was to have a way to evaluate student learning without the presence of the grade distribution. The final exam gave a good opportunity to reflect on how much students learned in not only Stat 822 but also in Stat 821, and how ready they are to take on the challenge to become a master level statistician where they have to solve real-world problems and whether they are ready to take the method questions of the PhD qualifier exam in our department.

I was pleased to see that most of the students performed exceptionally, and most of the answers illustrated their critical thinking and proficiency in explaining statistical concepts to people who are not familiar with these models and approaches.

8. Reflection on the Course

I feel fortunate to teach Stat 822 the second time, and to be able to offer in person instructions to students in the spring 2020 semester. I think overall the course was a success. Even-though Stat 822 is challenging, students appreciate the effort I put into preparing the courses, and six out of eight students expressed this in person after the semester was done.

When I talked to students at the end of the semester, I also took the opportunity to ask them how I could improve the class. Several students suggested to provide specific reading assignments throughout the semester related to the content we are discussing in class (additional to the Bayesian analysis notes that are required). In general, they were happy with the assignments and exams, and they felt they learned a lot in Stat 822.

9. Appendix – Course Syllabus

Stat 822 – Statistical Methods II – Spring semester 2021
Advanced Modeling – Methodology, Philosophy and Supporting Theory
class times: Lecture MWF 9:00-10:15 AM
Instructor: Dr. Reka Howard
email: rekahoward@unl.edu phone: (402) 472-2924
Office: Hardin 342B
office hours – Reka Howard: MWF 10:15 a.m. -10:55 a.m. (in person)
Teaching Assistant: Qianmei Wu
email: qianmei.wu@huskers.unl.edu
office hours – by appointment (via zoom)
Required Textbook:
Stroup, *Generalized Linear Mixed Models: Modern Concepts, Methods and Applications*
SAS for Mixed Models, Introduction and Basic Applications
Jim Albert: Bayesian Computation with R
Recommended Textbook:
McCulloch, Searle, and Neuhaus Generalized, Linear, and Mixed Models, 2nd Edition
On-time policy:
Early is on time and on time is late. Students are expected to be in class and ready to start at 9:00 a.m. I reserve the right to give pop quizzes at the beginning of class. Students who show up late, i.e. at 9:00:01, will get a zero on these quizzes.
Cell phone policy:
Turn them off, or put them on vibrate only before class.
Who Should Take This Course:
This course is the second of a three semester sequence that forms the core curriculum in the theory and application of statistical methods for a Master of Science degree in Statistics. It is intended for graduate students majoring in Statistics or minoring in Statistics but taking the full sequence of prerequisite theory courses. Specifically, *you must have taken (and passed) the probability and math stat sequence (Stat 882 and 883 or equivalent) or be concurrently taking the Stat 882/883 sequence in order to take this course*. *No exceptions. Also, you must have taken the first course of the three semester sequence (Stat 821). No exceptions.*
What this Course is About:
Contemporary statistical methods involve a combination of design and planning (what goes on before and during the time data are collected), statistical modeling (how, from a mathematical and probability point of view, do we account for variation in the data, and how are the data to be analyzed), modeling theory (what is the conceptual basis for the methodology we use and what is its theoretical justification) and general knowledge of statistical inference and communication (how do we interpret and report the results of an analysis).
More specifically: we will focus on finishing up basic design of experiment concepts from Stat 821, we will cover maximum likelihood estimation, mixed model theory, GLM, GLMM, and Bayesian data analysis.

Questions via Email

If you have a "life situation" (you're ill, something just came up & you need to miss class, etc.) please communicate via email. Otherwise you can lose some points for attendance.

Grading

Grading will be based on the following criteria:

- Regular homework exercises
- In class discussion
- Short reports and/or projects/quizzes
- Exams (three exams, including the final – **roughly** after week 5, week 10, and finals week)

The following table shows grading criteria for the course:

Exams		60%
Quizzes		10%
Class Participation		10%
Homework		20%

Week	Dates	Material covered in class	Reading material
1	Jan 25 - 29	Design of Experiments, finish Stat 821 material	Design of Experiments (Stat 802 notes)
2	Feb 1 – 5	Maximum likelihood estimation	Design of Experiments (Stat 802 notes)
3	Feb 8 -12	Mixed Models	Intro to Bayesian Data Analysis
4	Feb 15 -19	Mixed Models	Bayes – Single parameter models
5	Feb 22 -26	Mixed Models	
6	Mar 1 – 5	Mixed Models, Introduction to GLM	Bayes – Single parameter models
7	Mar 8 – 12	Introduction to GML	Bayes – Multi parameter models
8	Mar 15 -19	GLM	Bayes – Multi parameter models
9	Mar 22 -26	GLM	
10	Mar 29 – Apr 2	GLM	Bayes - Computation
11	Apr 5 -9	GLMM	Bayes - Computation
12	Apr 12 -16	GLMM	Bayes - Computation
13	Apr 19 - 23	GLMM	Comprehensive exam questions
14	Apr 26 – 30	Tie up loose ends	Comprehensive exam questions
15	May 3 -7 (Final exam: Monday, May 3rd 10am-12pm)		

The plan is to have two midterm exams and a final exam in this course. The format of the exams is not decided yet but it is very likely that the midterm exams will be closed book-in class exams, and the final will be a take-home exam.

Q: will I give an early/late make-up exam to students who want to book a flight home for a break before/after the scheduled exam time?

A: No, I will not. Please do not ask. Students are expected to be at the exams when it is scheduled. If you miss an exam without a valid excuse (booking a flight early is not a valid excuse), you will receive an incomplete for the course, which you will not be able to resolve until the Spring Semester, 2022.

Extra rules:

- Homework solutions have to be printed AND posted on Canvas to receive full credit. All of the homework solutions have to have the names of the group members/or individuals on them. Otherwise points will be taken off. I reserve the right to deduct up to 10% of the homework points for missing anything mentioned above.
- There won't be any extra credit opportunity in this class.
- If the homework is assigned as a group project work hard in your study group. Working on the homework assignments should be a group effort, and each of the members should work on them equally, and everybody should understand all of the problems. Otherwise you will have difficulty with the exams. If you have a problem with your group members please talk to me, and don't wait until there is a real problem. I won't play detective but I can (randomly) assign new groups.