Teaching Dossier

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Teaching Philosophy

In the second grade, I wrote weekly letters to my parents, updating them on the new topics I was learning in school. I couldn't help but express my excitement about learning division and the possibility of applying my newfound skill to "bigger numbers." My favourite subject was mathematics, as it remains. While I have always been naturally drawn to numbers, I realize this is not the case for many students required to take an introductory statistics course. And I can't say I blame them – statistics is really hard.

Statistics has evolved from being a subfield of pure mathematics, taught *by* mathematicians *to* mathematicians, to becoming a required component of high-quality, effective research across almost all fields. Statistics is built upon a handful of fundamental ideas sometimes only genuinely understood for the first time in upper-year major courses. Yet, these concepts are also necessary early in one-semester general statistics courses. Any students that fail to immediately grasp these building blocks may begin to feel left behind, becoming quickly discouraged, and reaffirming false ideas that they "aren't a math person after all". These feelings are further exasperated by a limited or distant background in mathematics or programming, requiring students to juggle many balls at once without developing any feelings of mastery.

While I don't believe that students can master all of statistics in a single course, I do believe it is possible to instill the skills that students need to "think like a statistician" without sacrificing core competencies. Statistics *is* beautiful, and I feel fortunate to have the deep understanding that I do. Many students do not desire mastery of statistics, but rather seek only the know-how required "to get the job done." While formulas are the language of mathematics and are certainly necessary to understand the complex mechanics of statistics, they are no longer the be-all, end-all of statistics education. Like anything else in academia, one needs to be aware of their audience.

Statistics does not occur in a vacuum. Many statistical methods arise from the need to solve real problems and are quite intuitive when supplemented with graphical tools, statistical software, simulations, real life examples, and thought experiments. To prevent students from relying on ineffective rote memorization of course materials, they should be encouraged to understand the thought process behind and practical application of statistical methods. Students may then use these same thought processes to critically evaluate not only their own research, but also journal articles and other media encountered in their academic and everyday lives. Students will quickly realize that statistics is ubiquitous and much less abstract than once thought and begin to feel confident in their ability to join the conversation.

To succeed at "statistical thinking", students from any discipline must, at the very least, acquire a high-level understanding of the fundamental or "big ideas" of statistics, including averages, the measurement of error, and sampling distributions. It must be made clear how these tools can be used effectively to evaluate research questions and translate them into statistical hypotheses or estimands which provide meaningful and actionable insights. Students must also develop a confidence in their ability to problem solve when complex, real-world research questions

do not align neatly with the simple methods often presented within the context of perfect designs. To achieve these competencies in statistical thinking while ensuring that no student gets left behind, I rely on several interacting strategies.

Statistics is not a "necessary evil" but a "helpful friend". The importance and role of statistics within research *must* be made explicit. Fostering an understanding of statistics' end goal can assist in motivating students to continue their studies, even when material gets complex, but also assists in answering the common question, "why do I have to take statistics if I'm in 'major'?" Using examples specific to the students' field can assist in connecting them to the material and can serve as a tool to guide them in their own research. I accomplish this by using excerpts of journal articles from relevant fields in lecture materials as well as within assessments, when possible, always providing citations should students be interested in exploring topics further. Assessments are also structured to rely on real data sets to further demonstrate the relevance and possibilities of statistics.

Try, try again. Statistics is a practice and best learned through trial and error. While understandably frustrating, unsuccessful attempts assist in developing the intuition needed to identify mistakes as well as the autonomy to find and implement the resources required to address them. Successful problem-solving attempts build confidence and reinforce concepts. To mitigate the anxiety students naturally feel with respect to failing, I acknowledge that much of research and really most things in life are iterative. I aim to foster an environment in which students feel safe to fail fast by always providing them with several attempts to correct their work and encouraging students to work through their problems together with me during office hours.

Look at it from all sides. Different people, and especially different fields, conceptualize problems differently. While some students and researchers may find different names for the same method frustrating, this arises naturally. Tukey once said, "statistics lets you play in everyone's backyard." I believe this is one of the biggest strengths and appeals of practicing statistics and it should be leveraged in teaching. Students have varying learning styles and approaching problems from several different angles assists in reaching as many students as possible.

Provide a flexible framework to build upon. Methodology flowcharts may be criticized for over simplifying problems and their solutions, but their frequent appearance in statistics courses suggests they serve an important purpose. There is rarely ever a correct answer to any problem approached with statistics. If there is, we are certainly not privileged to it. Students should be encouraged to be creative with their approaches, using the wealth of tools at their disposal, but approaches must also be disciplined. While there are no right answers in statistics, there are certainly poorly justified ones. Generalized frameworks like PICO (Population, Intervention, Comparison, Outcome) used to define studies in Epidemiology can and should be introduced for statistics. Such frameworks assist students with thinking holistically about projects from start to finish and provide a principled starting point for justifying difficult but critical research decisions.

I am a particular fan of UWaterloo's PPDAC (Problem, Plan, Data, Analysis, Conclusion), but am always on the lookout for new and perhaps snazzier options.

While I have framed my teaching philosophy thus far with respect to non-major students, I believe these processes are of equal or even greater importance for students already interested in and engaged with statistics. The pathways for a statistics major following graduation are numerous. Students should be aware of the responsibilities and opportunities of career statisticians, armed with the critical thinking needed to tell good practice from bad and reflect on their own decisions, possess the flexibility and visibility to pursue practice in whatever subject matter inspires them, and be strong communicators to advocate for their ideas and ensure their research has the impact it deserves.

Teaching Responsibilities

Teaching Assistantships

Multivariable Methods in Biostatistics (BIOSTATS 3110/9521)

- Winter 2021 (grad n = 26); Winter 2022 (grad n = 35); Winter 2023 (undergrad n=18)
- Grading, lab facilitation, and office hours
- Regression modelling strategies for Medicine and Epidemiology, generalized linear models, estimation and hypothesis testing, interpretation of results.

Principles of Biostatistics (BIOSTATS 3100/9509)

- Fall 2021 (undergraduate n=13, graduate n=26); Fall 2022 (n=36)
- Grading assignments and exams, office hours, and development/delivery of lab materials.
- Weekly lab topics focused on the application of statistical methods using statistical programming (SAS) and interpretation of statistical results within context of research problem.

Statistics for Business Decisions (STAT 2060DE)

- Summer 2016 (n = 60)
- STAT 2060 is an introductory, applied statistics course for business majors with limited to no prior experience in mathematics or statistics. The S16 offering was delivered in a distance education (online) format.
- Topics included the role of statistics in business, data entry and organization, random variables and their distributions, sampling distributions, interval estimation, hypothesis testing, and simple linear regression.
- My responsibilities included grading exams, responding to questions and engaging in conversations on the course's forum, and answering student e-mails.

Statistics I (STAT 2040)

- Winter 2016; Fall 2016 (n=319)
- Grading assignments

Course Development

Statistics for Business Decisions

- Summer 2015 to Winter 2016
- Developed Maple TA assessments and textbook materials

Evidence of Teaching Effectiveness

Student Feedback

"Emma's office hours were very helpful for me, they consisted of bringing up any concepts that I was having trouble understanding, going through mistakes I made on assignments or tests, answering any question I had and providing study tips. Statistical concepts are not a strength of mine and I really struggled understanding them. Emma's ability to communicate statistical concepts really helped me improve in the course. Emma would communicate concepts with examples, made sure I was following along throughout her explanations and if I needed something repeated, she would adapt her explanation so that I could better understand it. Everything I have learned from Emma has been helpful to this day. When Emma was my TA she advised me to write out a document of interpretations for different effect estimates which I still use. Also, concepts of multivariate regression, checking assumptions and interactions have stuck with me since those concepts are all part of my research."

- Ariel Morales, M.Sc. Student in Physical Therapy, BIOSTATS 9521 W21

"Emma is a great TA and a wonderful teacher. She has the amazing ability to explain complex statistics in easy-to-understand plain language. She's friendly, patient, and approachable, happy to help the students with not only particular questions but also how to approach similar problem solving. Her office hours were always very helpful and clarified a lot of the concepts in the lectures and the textbook. I'm grateful to have Emma as my TA."

- Lux Li, M.Sc. Candidate in Epidemiology and Biostatistics, BIOSTATS 9521 W22

"Emma has a genuine passion for teaching and a sincere desire to see every student succeed. She went above and beyond to help students grasp complex concepts by providing clarification in an accurate, yet easy-to-understand manner. She was also very responsive and always available to provide feedback on assignments and tests. I strongly believe that her support was integral in helping me feel comfortable with various biostatical methods. Her skills and expertise shine through her work and I greatly appreciate her passion for what she does!"

- Samina Idrees, M.Sc. Candidate in Epidemiology and Biostatistics, BIOSTAT 9509 F21 & BIOSTAT 9521 W22

"To put it simply, Emma was an extraordinary teaching assistant as well as an experienced mentor. Not only was she able to communicate statistical concepts accurately, but she was also able to communicate such information eloquently and in a manner that was easily understood by myself and my peers. As I began my biostatistics course, I was very anxious about learning the complicated statistical concepts that were included in the curriculum. However, Emma made the transition from my introductory statistics course to my specialized biostatistics course seamless, ensuring to fill in the gaps in my knowledge in preparation for more difficult material. Every time I reached out to Emma for advice or help, I was met with kindness, open-mindedness, and patience, all of which are incredibly useful traits that make her an incredibly effective scientific communicator.

Furthermore, Emma provided useful feedback on my coursework which has benefitted me in my courses, but also in my professional endeavours. For instance, Emma noticed that many students in my class were struggling to summarize statistical findings in a clear and accurate way. As such, she took the time to create organized resources and used them to demonstrate the best way to present statistical findings in conclusions and write-ups. This skill was not only applicable to my coursework, but it has also been useful during my time as a summer research student. There have been several instances where I was asked to summarize the results of a data analysis, specifically to gather meaning from this analysis and highlight its importance. This is a skill that I learned from Emma, and had it not been for her guidance and patience as our teaching assistant, I cannot say that I would be able to effectively attribute such meaning to our data.

Moreover, as part of our course's curriculum, we were to learn about SAS, a statistical software which is used to conduct various analyses. This software can be difficult to adjust to, and most of the time it takes a while before an individual can feel comfortable using all the available functions. However, Emma ensured that we felt comfortable using SAS and she even took the time during our lab sessions to explain the useful functions which we would encounter while using the software. Although those functions were not necessarily always used in our lab assignments, Emma took the time to teach us about them so that we would be able to use them outside the classroom when the time came. This was of great benefit to me personally, since I have been able to use the knowledge that I gained from Emma during my summer research internship.

Finally, the most important skill that made Emma an effective teaching assistant and mentor was her humility and helpful nature. Oftentimes when faced by the questions of undergraduate students like myself, teaching assistants may find it frustrating and cumbersome to review basic concepts, seeing as we may have already learned the material in our previous courses. Emma made sure that even if a concept was covered in one of our previous courses, that she took the time to review it and ensure all students had the basic understanding that was necessary to handle higher-level statistical concepts. All of these skills and traits combined is what I believe made Emma such an effective teaching assistant and mentor, and I know they will make her very successful in her future."

- Idin Fakhrjahani, B.MSc. Student in Epidemiology and Biostatistics, BIOSTATS 3100 F21