Teaching statement: Striving to teach inclusively

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Teaching inclusively allows students of all backgrounds to excel, but it requires an inordinate amount of experience to perform successively. For me, teaching inclusively is defined by ensuring students of diverse academic backgrounds can obtain confidence and a sense of camaraderie as a community during their pursuit of biostatistics. Such goals are sometimes not achieved, as statistics courses could be densely-packed or appeal primarily to mathematically-inclined students. As a result, I have found through discussions with undergraduates that this teaching style can discourage students from other academic backgrounds from pursuing biostatistics. I have been awarded two teaching awards throughout my Ph.D. that demonstrate my active role in improving my teaching ability. However, I am constantly striving to improve my awareness of the students' varied needs. In this document, I describe how I have honed my practice of inclusive teaching through my experiences improving the same introductory undergraduate course over five semesters, co-instructing a new upper-level undergraduate course, as well as attending seminars about teaching (via Carnegie Mellon University's Eberly Center's Future Faculty Program) and mental health (organized by Carnegie Mellon University's Counseling and Psychological Services). While UW Biostatistics does not have an undergraduate program, my experience with undergraduates can translate to teaching a broad audience of Master and Ph.D. students.

Teaching "Statistical Computing" – Improving a course over multiple semesters

Through my five semesters teaching Statistical Computing (Course 36-350) in different roles, I experienced a wide range of successes and failures when implementing new ideas on how to teach inclusively. Statistical Computing is an introductory undergraduate course for all Statistics & Data Science majors at Carnegie Mellon University (CMU), with typically 120+ students. The goal was to teach students how to use `R` to have a solid coding foundation for all their later courses. I have interacted with this course over five semesters, first as a teaching assistant (TA) for a few semesters providing suggestions about course content and helping in labs, to as an assistant instructor with Professor Ryan Tibshirani in Spring 2018 making course content directly and constantly interacting with students, and finally as a primary instructor during CMU's summer session in 2018. This course became required for all the Statistics undergraduates when I first became a TA, and it was challenging to teach since students entered with a wide range of backgrounds. Some never have coded before but needed to become proficient by the end of the semester for the sake of their future courses, but others have taken many advanced coding courses prior but had to take the course nonetheless due to its required nature. This variance caused us to experiment with how to balance the course for our broad audience.

One particular topic we experimented with is unit testing – writing code to ensure that other parts of the code are operating correctly. This topic has always been challenging since novice coders

typically do not appreciate the importance of unit tests, and knowing how to write effective tests is an abstract concept with no singular "correct" answer. When we first added this topic to the course, we made a traditional lecture with cookie-cutter homework questions that asked students to write simple unit tests for basic functions. However, this turned out to be ineffective in the long run – the lecture material was not fun to teach, and the students were disinterested in this fleeting topic that was never mentioned again in the course. In Spring 2018, I took charge of revising the way we taught this topic by designing a more elaborate homework, which now had students write non-trivial algorithms and the corresponding unit tests as a form of debugging. This design required me to achieve a delicate balance. On the one hand, I made the homework more open-ended since the importance of unit tests was only apparent when the homework didn't provide explicit step-by-step instructions. On the other hand, since this course wasn't about computer science, I had to provide meaningful demos so inexperienced coders could still succeed. In the final iteration, when I taught this course myself in Summer 2018, I integrated this topic more throughout the entire course by discussing what unit tests students could write when debugging their upcoming homeworks. These changes made unit testing less of a stand-alone topic and more of a fundamental topic central to computing. Overall, these improvements had a positive and profound impact on the students, as I saw students implementing basic unit tests in later homeworks even when unprompted.

Aside from course content, I experimented with other teaching strategies to help foster a sense of community within the classroom. As a concrete example, I actively learned all the students' names, as this was highly effective in forming a connection with the students and demonstrating my investment in their success. During our in-class roll-call of the students every lecture, I practiced this skill as part of the course's mandatory attendance component. My visible effort to learn the students' names encouraged students to discuss their concerns with me more openly. Furthermore, I saw the students forming new connections amongst themselves over time since they witnessed my process of learning more about their fellow classmates. I was awarded a TA excellence award in 2017 for this course.

Teaching "Statistical genomics and high dimensional inference" – Putting inclusivity methods into practice

When co-instructing Statistical Genomics and High Dimensional Inference (Course 36-469) in Spring 2020, I had more flexibility in improving the course content to reflect the principles of teaching inclusively. I co-instructed this newly-offered upper-level undergraduate/Masters elective with Professor Kathryn Roeder, and it had a class size of 26 students. This interdisciplinary course taught students how to use sophisticated statistical methods to answer genomic questions. This course attracted students with a wide range of academic backgrounds – half came from the Statistics & Data Science department, but the remaining came from a mix of Computational Biology, Computer Science, and Mathematics. This diversity incentivized Professor Roeder and me to craft the course carefully so all the students could learn the statistical principles.

To accommodate the students' wide range of backgrounds, I designed the course mechanics to teach more inclusively, both in the lectures and in homeworks. For example, during lecture,

I reviewed foundational concepts in linear algebra (such as eigenvectors) since the students had varying comfort levels with these concepts despite having already completed prerequisite linear algebra courses. I tied together the mathematical definitions of such concepts, the intuition on why they're relevant in statistics, and the genomic questions these concepts can help answer. By delivering the material this way, students were able to learn regardless of their previous familiarity. For homeworks, I designed the homeworks to assess students' understanding appropriately, keeping in mind the wide range of backgrounds. For example, the homeworks primarily revolved around providing students with a genomic dataset and having them write code to replicate specific genomic-analysis plots and interpret them by writing a short paragraph. This design allowed less coding-skilled students to succeed by providing ample visual feedback for their otherwise-opaque code. It also allowed less statistically-skilled students to succeed by giving concrete plots to explain statistically. Second, I designed optional challenge questions that extended the course content to the research frontiers. These additional questions could satisfy the hunger of more advanced students who felt the graded portions were too easy. By deploying these mechanics, Professor Roeder and I saw that both inexperienced and advanced students were able to master new concepts. The final projects provided ample evidence of this – the students analyzed various genomic datasets to answer biological questions in a way that matched their interests. I was happy to see students (even the ones who did not enter with a strong coding or statistical background) craft thoughtful analyses using various visualizations and statistical methods taught throughout the course.

Another important goal for teaching inclusively was building a sense of community. This required new teaching strategies since the COVID-19 pandemic caused a sudden shift to remote learning. To encourage student engagement, I purposefully prompted questions during lecture and formed small breakout groups to achieve this goal in an online environment. To exemplify this former strategy, I asked students from different majors to suggest potential solutions to broad conceptual questions at the start of lecture. Then I would weave these different perspectives together throughout the lecture. This lecturing style allowed students to implicitly learn from each other, even in the remote environment. This sense of community solidified near the end of the semester when students felt comfortable asking follow-up questions to other students' prior questions. I was awarded a TA-of-the-year award in 2020 for this course.

Commitment to improving teaching and addressing mental health

While most Ph.D.'s in most Biostatistics departments do not typically spend time attending on-campus seminars to learn teaching strategies, I found the following experiences invaluable in my pursuit to teach inclusively. Below, I highlight various seminars/programs I attended to achieve this.

- **Eberly's Future Faculty Program's seminars**: Through these seminars, I have learned about teaching strategies such as Think-Pair-Share, which I wish to implement in the future, and techniques to build a sense of community or de-escalate tension within a classroom.
- **Eberly's Future Faculty Program's teaching observations**: Through Eberly's observations of my teaching, I have revised my ideas on how to encourage classroom discussion,

structure goals during lecture, and assess success beyond graded assignments.

- **Teaching Statistics (CMU 36-764)**: In this course, we discussed effective designs of multiple-choice questions and how to design homeworks that can discover students' current misconceptions.

Additionally, teaching inclusively is not only related to academics but is also related to broader issues of students' mental health and wellness. Through discussions as a member of CMU's Statistics & Data Science's Wellness network and training sessions organized by Carnegie Mellon University's Counseling and Psychological Services as well as the National Council's Mental Health First Aid Training, I have a better understanding of the emotional turbulence an undergraduate could experience. These sessions were incredibly informative, as they equipped me with concrete steps to de-escalate the tension, connect with the student, and help them find professional counseling when needed.

I have first-hand helped students develop positive mental health in times of emotional turbulence and stress when mentoring them in numerous undergraduate research projects over my Ph.D. The undergraduates, typically seniors, would be juggling research and coursework alongside job applications and personal sources of stress. My training in mental health made me more adept at assessing when a student was troubled outside of research. There is never a one-size-fits-all solution on how to handle the specific case-by-case details of what is negatively impacting a student's mental health. However, I found overarching themes throughout my different mentoring experiences that allowed me to help undergraduates nonetheless. These themes were exemplified most recently and extremely when I mentored an international senior undergraduate at CMU during the height of the COVID-19 pandemic while he was transitioning to become a Masters student at a different university. Understandably, this was an emotionally turbulent time due to the lockdown, remote learning, and difficulty of moving and international travel. As one example of a common theme to help students with mental health, I have found that explicitly acknowledging the difficulty and stressful nature of the situation can invite students to open up. Even when I do not have any particular advice, the students would slowly regain mental balance as they translate nebulous thoughts plaguing them into coherent sentences within a conversation. While I am not professionally trained in mental health, I am committed to expanding my understanding of how to best support students throughout their educational experience when appropriate, even in aspects not directly related to research.

Moving forward – Sharing my passion with the next generation

As I become a professor in biostatistics, I plan to continue my exploration and learn of how to teach inclusively for students of diverse backgrounds (such as through the Center for Teaching and Learning Resources). I welcome opportunities to teach courses analogous to the aforementioned Statistical Computing (such as BIOST 509: Introduction to R for Data Analysis in the Health Sciences) as well as Statistical Genomics (such as BIOST 545: Biostatistical Methods for Big Omics Data). I also welcome opportunities to teach courses on data science (such as BIOST 579:

Data Analysis and Reporting) – I have found skills such as visualization, data integration, and development of statistical models formalizing scientific knowledge are sometimes absent from a typical Ph.D. candidate's courses.

I am also committed to future outreach programs that engage with youths who did not have ample opportunity to learn the coding and mathematics skills implicitly required for biostatistics education (such as through the Summer Institutes in Biostatistics). I find that youths turn down paths to become statisticians or biostatisticians, not because they do not have the aptitude but because the learning environment, course material, and equipment feel too unfamiliar and unwelcoming to them. I strongly feel that it is our duty as academics to disseminate knowledge so that all students, regardless of their academic background, can thrive and feel included within the biostatistics community. In my experience, many students often perceive statistics as a topic filled with math equations and flowcharts. However, practices of teaching inclusively can overturn such misconceptions. By rethinking the course mechanics and having an attentive eye on mental health, I hope to successfully guide students and inspire them to think statistically, even beyond the course.