1 Overview of Teaching Interests and Previous Teaching Experience

Teaching interests. I am broadly interested in teaching courses that relate to my research interests and interface closely with engineering and the physical sciences. At the lower levels, I enjoy teaching calculus courses, as this is where I first developed a passion for mathematics. I take pleasure in introducing students to the essential tools of calculus, as well as the use of these tools in the mathematical modeling of innumerous real-world phenomena. I am also passionate about the teaching of introductory proofs courses which serve to bridge the gap between lower- and upper-level classes, and teach students to write and understand rigorous mathematical proofs. In my opinion, these introductory proofs courses are as much about developing oral and written communication skills as they are about teaching mathematics. I have experience in teaching both introductory calculus and proofs courses and would be excited to continue teaching them in the future. At the upper levels, I am interested in teaching courses relating to numerical analysis, such as numerical linear algebra or scientific computing. Specifically, I am interested in teaching the computational aspects of mathematics which arise in the study of numerical algorithms, like stability, complexity, and accuracy, as well as the underlying theory.

Previous teaching experience. During my graduate studies at Virginia Tech, I have been the sole Instructor of Record for the courses listed below. As an Instructor of Record, I am responsible for the design and delivery of all course materials, including lectures, homework assignments, and exams.

MATH 1225: Calculus of a Single Variable (Fall 2021). This is the first course in a standard university calculus sequence; it covers the fundamental concepts of differential and integral calculus for functions of a single real variable, and is required for all math and engineering majors at Virginia Tech.

CMDA 1634: Discovering Computational Modeling and Data Analytics (Fall 2022). This is offered to all first-year students in the Computational Modeling and Data Analytics (CMDA) major at Virginia Tech. In the Fall of 2022, there were 115 enrolled students. The purpose of the course is to familiarize new students with the coursework and topics they will encounter in the CMDA major, expose them to fundamental skills and tools in scientific computing, and teach different aspects of professionalism. Every week, students attend lectures taught by either myself, a member of the CMDA faculty, or campus partners. For example, in one lecture I taught students the basics of scripting using Python and Jupyter notebooks. During a different lecture, a representative from Virginia Tech's Center for Career and Professional Development delivered a resume workshop to help prepare students in applying for internships. As the instructor of record, I was responsible for the planning and coordination of the guest lectures. I also oversaw a team of 12 Undergraduate Peer Mentors and 1 Graduate Teaching Assistant. At my direction, the teaching assistants coordinated in-class activities and graded student assignments.

MATH 2534: Intro to Discrete Math (Fall 2023). This is a sophomore to junior level course that covers introductory topics in discrete mathematics, such as elementary number and set theory. At Virginia Tech, Intro to Discrete Math also serves as an introductory proofs course for non-mathematics majors. The course content covers the basics of propositional logic, proof techniques such as proof by induction and proof by contradiction, and introduces students to the normative standards expected of rigorous mathematical proofs. Additionally, I placed a significant emphasis on technical writing.

At Virginia Tech, I have also been a Graduate Teaching Assistant for the following course.

CMDA 4864: Computational Modeling and Data Analytics Capstone (Fall 2024). This is a required senior-level capstone course for CMDA majors. Teams of 3 – 4 students spend the semester tackling open-ended data science problems provided by academic and industry sponsors. As a Graduate Teaching Assistant, I am responsible for advising 3 of these teams in their research projects. My primary duties are assisting students in navigating the technical and interpersonal challenges that arise during the completion of their project, as well as preparing written technical memos and oral presentations.

Prior to my beginning my graduate studies in mathematics at Virginia Tech, I was a Resident Teacher with Urban Teachers, a teacher preparation program. During this time, I taught at New Era Academy, a high school in Baltimore City, Maryland. As a part of this program, I took eight courses through the Johns Hopkins School of Education on the topics of pedagogy, race, social justice, equity, effective instructional practices relating to classroom management, algebraic thinking, and proportional reasoning skills. To this day, I incorporate the knowledge gained from these courses to inform an effective and equitable teaching practice.

2 Teaching Practice and Philosophy

In my teaching, I strive to cultivate a learning environment where students take an active role in exploring the course material through engaging with complex tasks and participating in a healthy mathematical discourse with their peers. I do this by motivating the lecture material with real-world applications and by building relationships and rapport with my students, thereby creating opportunities for engagement through group work and hands-on examples. Below, I share some of the core philosophical tenets that guide my teaching practice.

1. Students learn best when the lecture material is substantively motivated. I am a firm believer that passion is contagious. In my past experiences as a student and an educator, I've found that an enthusiastic teacher cultivates enthusiastic students. I can confidently say that I would not have gone on to study mathematics had it not been for my high school calculus teacher, who shared his passion for the subject with me. Because of this, I always communicate my excitement for mathematics and its far-reaching applications through my words and body language when delivering a lecture or leading a classroom discussion.

Whenever possible, I open a lecture by framing the day's content in the context of a meaningful real-world application of the mathematics, or by providing some historical significance. For example, to motivate the study of prime numbers in my Intro to Discrete Math course, I discuss the application of large primes in cryptographic systems and protocols, and introduce them to the typical "Alice and Bob" example in public key cryptography. I also tailor these examples to the interests and experience of my students. When teaching Calculus of a Single Variable, roughly 90% of my students were engineering majors. I regularly used examples from my personal research background in dynamics and systems and control theory to motivate the course content. To contextualize the mathematical technique of linearization, I described how linearizing a nonlinear dynamical system about a stable equilibrium point is often the first step in designing an optimal regulator for controlling the behavior of such a system. Grounding the course material in real-world applications also makes abstract concepts more palatable to students. The benefits of this practice were evident; during anonymous teaching evaluations at the end of the semester, multiple students cited this practice as a reason they found the course material interesting and easy to understand.

2. Students learn mathematics by doing mathematics. In my courses, I incorporate opportunities for students to be directly involved with the lecture through group work, hands-on examples, and peer-to-peer mathematical discourse. At least once per week, students work in small groups of $3-4$ to solve a sequence of increasingly difficult exercises, or tackle an open-ended mathematical problem. As an example, when introducing methods of direct proof in my Intro to Discrete Math class, I use the following activity. Students are presented with three "proofs" of the implication: *The sum of any two odd integers is even.* The objective is for each group to examine each of the given arguments, and decide whether or not they are sufficient to establish the truth of the given statement. Firstly, students are encouraged to reflect on the task alone, and generate ideas based on their own mathematical understanding of what constitutes a "proof". Secondly, students aggregate into their small groups, and work together to form a consensus for each of the given "proofs". Thirdly and finally, different groups present and defend their ideas in front of the class. I find this task is useful for establishing mathematical norms around what suffices as a rigorous proof; it also challenges students to confront their pre-conceived notions about mathematical proof derived from their previous coursework. The formula described above is the framework I follow when facilitating group mathematical tasks. This offers the students an opportunity to hone their presentation skills by engaging with their peers in a low-stakes environment.

I believe that self-guided mathematical discovery is an important part of becoming an effective problem solver, particularly as students continue on to higher-level courses with more open-ended problems. Because of this, I include exploratory examples into my lectures so students can experience this process in the presence of a teacher who is there to provide real-time feedback. Before formally introducing the Intermediate Value Theorem to my Calculus of a Single Variable students, I ask them to draw the graphs of functions which satisfy some subset of the Theorem's hypotheses. One such example is: *If possible, draw the graph of a function f for which $f(1) < 0 < f(3)$, and $f(x) \neq 0$ for all $x \in [1, 3]$.* For this particular example, most students will produce the graph of a non-continuous function. Based on a sequence of similar examples, we eventually come to class consensus on what conditions a function $f(x)$ must satisfy in order to "achieve" a particular value. Then, I introduce the Intermediate Value Theorem formally and revise the implications of each hypothesis, in order to reinforce the ideas just explored. This process of discovery is particularly effective for scaffolding student independence.

I also incorporate computing into my teaching when possible, either through live demos or extended problem sets. This allows for students to see the theory they learn in class illustrated or applied directly to a relevant problem. I found this to be particularly useful in teaching Intro to Discrete Mathematics; I demonstrate that computation can be useful for checking conjectures or developing counterexamples. In the future, I will take this a step further, and incorporate short projects into my courses that combine some aspects of theory and some aspects of computation.

3. Fostering an environment of trust is necessary for student engagement. I believe that establishing a healthy rapport and atmosphere of trust between student and instructor is essential for creating a space in which students feel comfortable engaging with challenging mathematics. For many students, mathematics is a difficult subject and often a significant source of anxiety; I have noticed that there is a persistent belief among students that one has to produce a correct solution on the first try, and that failure to do so is an indicator of one's academic ability. If we expect our students to engage productively with challenging problems as mathematicians, then we are obligated to create an environment in which they feel comfortable struggling with such problems. I impress upon my students from the first day of the semester that making errors is an unavoidable, necessary, and welcomed part of the learning experience. When introducing a challenging concept, I regularly recount my own past struggles and misunderstandings of the same curriculum from when I was an undergraduate. I am also quick to acknowledge my own mistakes during a lecture, and welcome students to question anything I do that seems unclear or incorrect.

Another way I foster a trusting environment is by seeking out meaningful one-on-one interactions with my students. Office hours are an important part of this formula; while this allows students to ask questions and clarify misunderstandings, it affords me the opportunity to learn about their background and interests in a less formal, individualized setting. I also continuously incorporate student feedback into my teaching. At the beginning of every semester, I have students complete a short survey regarding their past experiences with mathematics, and their preferred learning styles. Midway through the semester, I send out an additional survey to elicit anonymous feedback on my personal teaching style. I use this feedback to continuously improve my teaching practice for the remainder of the semester. Whenever pertinent, I communicate the rationale behind my pedagogical and course policy decisions. I find that pulling back the curtain and revealing "why" behind my decisions imbues trust and encourages buy-in. For instance, students are often hesitant to engage with group work and in-class activities. However, I explain that one of the primary reasons I assign in-class work is to provide them with real-time feedback as they're solving problems. I also prefer to assign challenging problems on homework assignments as opposed to written exams. I find that the increased time afforded to students for completing homework leads to increased engagement, without the external stress of a time constraint. I communicate this to my students, and let them know that because the homework is designed by me to be challenging, that I am more than willing to answer their questions and offer them guidance during office hours. Students have responded very well to this, and expressed that they feel supported by me to rise to the challenge of such difficult problems.

3 Evidence of Effective Teaching

As an instructor of record, I have been evaluated anonymously by my students via Virginia Tech's Student Perceptions of Teaching (SPOT) evaluations. In this evaluation, students provide quantitative and qualitative feedback on various facets of my teaching practice. Here, I include student ratings and responses to the following selected questions:

Q1 *Please indicate the extent to which you agree or disagree with each of the following statements on a scale of 1-6, 6 being Strongly Agree: "Overall, the instructor's teaching was effective."*

Q2 *What did the instructor do that most helped in your learning?*

Q3 *Please add any additional comments regarding the course and/or instructor here.*

Q1 collects quantitative feedback; **Q2** and **Q3** are free response questions which collect qualitative feedback. Table 1 records the average *"Overall teaching effectiveness"* scores as rated by my previous students in response to **Q1**, organized by class and semester. The average *"Overall teaching effectiveness"* scores for all instructors of record across all courses in the Virginia Tech mathematics department or CMDA program are also provided for each semester.

Semester	*Fall 2021*	*Fall 2022*	*Fall 2023*
Class	MATH 1225	CMDA 1634	MATH 2534
My average score (Out of 6)	**5.83**	**5.31**	**5.69**
Department average score (Out of 6)	4.33	5.27	4.67

Table 1: Student responses to **Q1** for each semester I was an instructor of record.

Below are a selection of student responses to **Q2** and **Q3**.

MATH 2534: Intro to Discrete Math (Fall 2023).

Q2 *"Sean would relate most of the ideas to some real-world application or example, which made a lot of the more complex topics much easier to understand. He also broke down a lot of the in-class example problems down to their most basic parts, which was really helpful in helping us learn how to solve the problems ourselves."*

Q3 *"Excellent instructor. Very easy to talk to and helpful both in-person and through email. The examples and proofs done in class made the material relatively easy to understand, and he was always happy to answer questions in class and would often answer them in-depth and make things very clear."*

Q3 *"You were an amazing instructor and I'm very glad that I took your course. You took the time to get to know your students, and you never failed to help them achieve their goals in this course. This for me personally made a big impact in the effort that I took in the course by going above and beyond studying, preparing for exams, hw assignments, and office hour questions. Best math teacher that I had at Tech, to the point where I was interested and craved learning how to solve proofs."*

MATH 1225: Calculus of a Single Variable (Fall 2021).

Q2 *"He gave the class many tips on how he was able to better understand and remember the course material when he took the class. He also gave us explanations for why the course material was pertinent to various fields, which made the class much more interesting"*

Q2 *"He made sure to reach out when I wasn't coming to class and was very understanding about my external circumstances and how it affected my performance"*

Q3 *"Most professional and well prepared instructor I have had at Virginia Tech."*