Teaching Portfolio

Apurva Nakade

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Contents

Introduction

I am a postdoctoral lecturer in the Department of Mathematics at Northwestern University. I was a postdoctoral fellow at the University of Western Ontario from 2019 to 2021. I obtained my Ph.D. from JHU in 2019 with a thesis titled *An application of the h-principle to Manifold Calculus*.

My academic responsibilities have included:

- coordinating and teaching multi-section courses,
- teaching in-person and online courses with several hundred students,
- adapting large service courses for asynchronous education,
- creating advanced electives and short boot camp courses for small groups of students,
- managing TAs,
- hiring mentors for summer camps,
- supervising reading courses and reading programs,
- creating open education resources such as video lectures and Webwork questions,
- creating course content using RMarkdown and PreTeXt,
- formalizing mathematics in Lean theorem prover.

I have taught topics spanning calculus, linear algebra, differential equations, linear programming, discrete math, math formalization, manifolds, and algebraic topology. In recent years, my focus has been on creating course content that is reusable, adaptable, and freely available. I'm interested in creating and redesigning interdisciplinary math courses focusing on real-world applications and modeling.

Chapter 1

Teaching Statement

Teaching Philosophy

I believe the best way to learn math is by making mistakes, getting confused, and struggling toward a solution. I consider myself a coach and a facilitator. I teach with the core philosophy that my primary goal is to provide my students with a welcoming and inclusive environment where experimentation is encouraged, and honest mistakes aren't penalized. I incorporate active learning in all my classes. A math classroom is a place for students, and even the instructor, to grow as mathematicians.

Use of Technology

Students retain their knowledge better when they engage with a subject through multiple modalities. Technological tools are perfect for accomplishing this. I created weekly Excel worksheets for modeling linear programming scenarios for teaching linear programming. For Discrete Math, I used an online textbook with (mandatory) interactive activities scattered throughout the text and made YouTube videos for each section embedded directly in the book. Student responses to these have been overwhelmingly positive. I intend to use modeling resources provided by SIMIODE* to teach Differential equations.

I strongly believe in making education more accessible by creating open educational resources (OER). We now have the technology to accomplish this. I have co-received an OER Faculty Grant for adding WeBWorK exercises to my colleagues' Linear Algebra OER textbook written in PreTeXt. I also intend to turn my Optimization course notes into an OER textbook.

Diversifying Assessments

Students often perform poorly on exams not because of a lack of understanding but because of exam anxiety and a lack of exam-taking skills. Traditional exams do not faithfully represent the challenges students are likely to face in real life either. As such, in every course I teach, I provide a variety of assessments explicitly catered to students' needs. In my Optimization course, students had to submit an Excel Workbook involving several modeling exercises instead of taking a final exam. For Discrete Math, taught during Covid, we created a repository of new WeBWorK problems over the summer and replaced in-person exams with WeBWorK and Zoom. Students also had to submit weekly short auto-graded assignments within the textbook, which provided immediate feedback. I also made a detailed rubric focused on evaluating the quality of proof-writing. For the Algebraic Topology course, I replaced the final exam with an oral and a written report as I was more interested in testing students' ability to approach a challenging problem than coming up with rigorous proofs under time pressure. In my current honors linear algebra course, I'm giving students short weekly quizzes during discussion sections with no time limits to ease them into the university exam system.

*Systemic Initiative for Modeling Investigations & Opportunities with Differential Equations, https://qubeshub.org/community/groups/simiode

Course Design

When (re)designing a course, I try to imagine the class from a student's perspective and adapt it to their level of mathematical maturity while being vigilant of the expert blind spot. It is essential for me that my course is meaningful and intellectually fulfilling to students. I completely restructured my Optimization course to make applications and modeling a critical component. I created detailed notes using RMarkdown as I did not find books with the right mix of theory and applications. I have designed and taught an entirely flipped Honors Single Variable Calculus course at JHU. I learned a lot about how to get students engaged in a classroom from this experience. At Canada/USA Mathcamp, I had to develop and teach a five-day undergraduate math class every week for five weeks while being involved with other camp activities. I could not have asked for better training grounds for course design. Notes for many of these classes are available on my website.

Classroom Environment

I strive to get my students comfortable with the messy process of discovery in math. My classes are fun, interactive, and often flipped. I memorize all my students' names to connect with them. In every class, I require students to solve problems and roam around to check on their work. I hold many office hours in a collaborative space that encourages group work. My office hours always have high attendance and tend to turn into group study sessions. They allow me to observe how students approach problem-solving, enabling me to provide them with pointed feedback.

I make great efforts to ensure that a course syllabus is welcoming and encouraging, being the first document that students see. While teaching online during Covid, my priority was to alleviate student anxiety and ensure students were not disadvantaged because of the lack of face-to-face meetings and technical difficulties. After each (auto-graded) WeBWorK exam, I reviewed all student responses to reassign any points lost due to minor typos and system errors. I also maintained an active discussion forum on Piazza to foster a sense of community. I have taught coordinated courses where I was the sole point of contact for over 150 students. This challenging experience taught me how to be more inclusive and considerate of students from very diverse backgrounds and ensure that even those with other priorities can benefit from learning math in whatever way possible.

Professional Development

I keep myself updated on the advances in pedagogical techniques and find it valuable to hear about other educators' experiences. I am a member of the Project NExT'20[†] cohort. I have completed a certification course at the Teaching Academy at JHU, where I learned about several pedagogical concepts, such as inquiry-based learning, backward course design, and learning objectives, which I regularly incorporate into my teaching. I have regularly attended workshops and seminars organized at the Center for Teaching and Learning at UWO and NU and, most recently, MAA Open Math Workshops, SIGMAA IBL workshops[‡], and Online Seminar On Undergraduate Mathematics Education. In addition to providing me with new information and skills, these workshops also allow me to take on the role of a student and stay an active learner.

Mentoring

I find it fulfilling to mentor students outside of the regular classroom setting. I am currently a supplementary instructor for the Causeway Postbaccalaureate Program, a yearlong experience in mathematics that seeks to increase the number of graduate students in the mathematical sciences from historically underrepresented groups. I have organized and participated in a Directed Reading Program that pairs undergraduate students with graduate students/junior faculty to undertake independent study projects as a mentor and a co-organizer. I started a DRP chapter at UWO with the help of one of my colleagues. At JHU, I held review/problem-solving sessions for graduate students to prep them for their algebra prelims.

[†]A professional development program sponsored by the MAA for math educators at the university level, https://www.maa.org/programs-and-communities/professional-development/project-next

[‡]Special Interest Group of the Mathematical Association of America, http://sigmaa.maa.org/ibl/

My biggest influences have come from being a mentor (2017-20) and an academic coordinator (2018) at the Canada/USA Mathcamp, a summer program for high school students. Mathcamp allowed me to be a part of a loving and caring community, surrounded by people who love math and love to teach and excel at it. I took on the role of an academic coordinator to contribute back to Mathcamp, challenge myself, and learn more about teaching. The academic coordinators are responsible for designing and running all the educational activities, including inviting and hosting external visitors, planning a balanced five-week class schedule (nearly 60 classes), assigning (110) students to projects, and teaching.

Future Goals

In the future, I want to design and teach more interdisciplinary courses that involve student projects and real-world applications. I am also interested in making existing math courses more applied, especially courses aimed at non-math majors. I want to incorporate active learning in coordinated courses without putting undue pressure on individual instructors. This is particularly challenging as most instructors are primarily researchers and often have limited time to dedicate to teaching. The solution is to develop structured resources (like online asynchronous assessments, modeling first textbooks, programming assignments in SageMath, and IBL scripts) to enable instructors to incorporate active learning in their classrooms at no extra cost. Finally, I am currently contributing to Open Education Resources. I want to expand these projects in the future with a focus on online assessments, as this is the main bottleneck in successfully adapting courses to an online setting.

Chapter 2

Teaching Experience

2023 Spring[*]	Elementary Differential Equations
2023 Winter	Foundations of Mathematics
2022-23	MENU Linear Algebra and Multivariable Calculus (Course Coordinator)
2021-22	MENU Linear Algebra and Multivariable Calculus (Coordinated)
2022 Spring	Introduction to Optimization
2022 Winter	Introduction to Optimization
2021 Fall	Single Variable Calculus (Coordinated)
2021 Winter[†]	Algebraic Topology
2020 Fall	Discrete Structures for Engineering (Online, Asynchronous)
2020 Winter	Calculus II for Mathematical and Physical Sciences (Coordinated)
2019 Fall	Calculus I for Mathematical and Physical Sciences (Coordinated)
2019 Fall	Topics in Category Theory
2018 Fall[‡]	Honors Single Variable Calculus
2018 Winter	Symmetries & Polynomials
2017 Fall	Honors Single Variable Calculus
2017 Winter	Hitchhiker's Guide to Algebraic Topology
2017 Summer	Differential Equations with Applications
2015 Summer	Differential Equations with Applications
2014 Summer	Online Linear Algebra
2017-20	Various Canada/USA Mathcamp courses
2018	Canada/USA Mathcamp Academic Coordinator

Below I provide details about several of my courses.

2.1 Introduction to Optimization

Northwestern University, Fall and Winter 2021

[*]Northwestern University
[†]University of Western Ontario
[‡]Johns Hopkins University

I taught this quarter-long course for two quarters in the Winter and Spring of 2021. The course was aimed at upper-level undergraduates majoring in math and economics. It covered the topics of linear programming, the simplex method, duality theory, KKT conditions, and applications. The class had, on average, 12, mostly final-year students.

- **Class Notes:** Most textbooks I encountered were either too theoretical or too applied. I failed to find one that was a good fit for this course. As such, I wrote detailed notes for this course in RMarkdown which can be found here: apurvanakade.github.io/Introduction-to-Optimization.
- **Excel Worksheets:** I designed the course to have both a theoretical and a practical component. The lectures focused on optimization theory, and the discussion sections on applications. Students had to model and solve optimization problems during the weekly discussion sections using the Solver tool in Excel. These were to be submitted at the end of the quarter and formed a significant assessment component. A sample worksheet can be found in the Appendix.

2.2 MENU Linear Algebra and Multivariable Calculus

Northwestern University, 2021-22 (instructor), 2022-23 (coordinator)

This is a year-long accelerated course covering the topics of linear algebra and multivariable calculus. I was an instructor for this course in 2021-22 and am currently (2022-23) the course coordinator. The class has nearly a hundred first-year and second-year students divided into three sections at the start of the year.

I noticed during my first year that students were extremely stressed in this course and we saw significant attrition. I believe that this is because the syllabus is not updated to the realities of a post-Covid world where students are on average less prepared and less mathematically mature. Many students in our class had not taken an in-person exam in over a year and had a skewed perception of their own preparedness.

As an instructor, I tried to support my students by providing a large number of office hours. This year, as a coordinator, I have substantially simplified the course structure to allow students time to catch up. I've shortened the exams by diversifying the types of questions. During the discussion sections, students take quizzes with flexible end times; the idea being to give them an opportunity to self-assess without making it feel like a test. I regularly encourage students to work in groups and have provided several resources to help them with mathematical writing, time management, and becoming better learners. I continue to offer a lot of office hours, which still see substantial student attendance.

2.3 Algebraic Topology

University of Western Ontario, Winter 2021

In Winter 2021, I taught a semester-long course at UWO on Algebraic Topology for graduate students and upper-level undergrads. This was a small class with six graduate and six undergraduate students. The primary textbook for the course was Hatcher. The course covered topics such as the fundamental group, covering spaces, and singular homology. This was a fully online course delivered over Zoom. I used GoodNotes for course delivery. I replaced the final exam with an oral and a written report as I was more interested in testing students' ability to approach a challenging problem than coming up with a rigorous proof under time pressure. The course relied heavily on solving conceptual homework problem sheets, which I paid meticulous attention to developing. The problem sheets for this course can be found here: problem sets.

2.4 Discrete Structures for Engineering

University of Western Ontario, Fall 2020

This was a semester-long four-credit course offered to second-year software engineering students. Students were introduced to fundamental concepts in discrete math, such as logic, combinatorics, modular arithmetic,

and proof-writing. I was the only instructor for this course. My class had nearly 200 students. I had to adapt the course to fit an online mode of delivery.

This has been the most challenging teaching project so far, as, over the summer, I had to adapt a regular course to an online asynchronous setting. While preparing for the course, my priority was to reduce student anxiety, simplify the course delivery as much as possible, and minimize the screen time for students.

- **Textbook:**

  I abandoned the traditional textbooks and chose an online one called Zybooks, which had interactive components and provided students with immediate feedback. The book is also highly comprehensive and contains copious amounts of auto-graded exercises and several practice problems, which I assigned weekly to help keep students on track. Finally, the book is exceptionally configurable in terms of content and structure. The textbook can be found here: learn.zybooks.com/zybook/UWOMath2151ANakadeFall2020

- **Video Lectures:**

  To minimize the required screen time for students, I made short videos for each topic instead of long ones for each lecture. Having a textbook that I knew would fill in the gaps left out by the short lectures was crucial for making this choice. I embedded these video lectures directly within the textbook to provide a centralized resource to students, much like other online platforms such as Coursera and Kaggle. The video lectures are also available on YouTube at the following link: https://www.youtube.com/playlist?list=PLXAOfwfSuiKm3cL-JftD9ndrjYi7fPcqN

- **Exam:**

  I decided to use WeBWorK to make exam problems. I chose WeBWork because it is robust and reliable and allows for internal randomizations within a question and randomization between questions. With my postdoc advisor and two students' help, we designed a repository of several hundred problems for discrete math on WeBWork. This repository is easily portable and adaptable to any discrete math course. An extensive repository of questions enabled me to create unique exams for every student.

- **Rubric for proofs:**

  This course introduced students to proof-writing in addition to logic and combinatorics. Teaching this in an online asynchronous setting was incredibly challenging, as providing students with immediate feedback is impossible. To remedy this, I decided to grade students on only the *writing* part of proofs. I designed the homework questions based on the textbook questions (for which the book provided detailed solutions) and gave students a rubric on which their writing would be graded. The rubric can be found in the Appendix.

- **Discussion forums:**

  I realized early on that communication would be the key to this course's smooth running. For this reason, I choose Piazza as a discussion forum to answer student questions and encourage them to answer each other's problems. Piazza is very intuitive, easily searchable, and allows for anonymous posts. Anonymized version of my class' discussion forum can be found here: https://piazza.com/demo_login?nid=kd1rr8nxc6z4b5&auth=f76e59e

2.5 Honors Single Variable Calculus

Johns Hopkins University, Fall 2017, 2018

At JHU, I got an opportunity to develop and teach Honors Single Variable Calculus for two semesters. This is an experimental full-semester four-credit course offered at JHU to first-year undergraduates. The course covers all first-year calculus and introduces students to proof writing.

This was the first course I had to design from scratch. In the previous years, the course was mostly taught in a lecture format. I decided to transition to a fully inquiry-based format. For this, I took the suggested textbook for this course and converted it into weekly guided exercises. Because the classes were small, I often

dynamically modified the course material to suit the class. Designing this course gave me insights into the process of student learning and I learned a lot about how to keep students engaged. The materials for this course can be found here: https://apurvanakade.github.io/for-students.html#honors-single-variable-calculus

2.6 Intersession Courses

Johns Hopkins University, Winter 2017, 2018

I taught two week-long intersession courses, *Hitchhiker's Guide to Algebraic Topology* and *Symmetries & Polynomials*. I taught both of these courses in a flipped classroom format. I assigned students guided exercises, which they solved to learn more about the subject. What was both challenging and fun was that the students were not math majors; I had to remove all the mathematical jargon and could not even expect them to know how to write proofs. I had to design my course around concrete examples and find easily accessible concepts.

For Hitchhiker's Guide to Algebraic Topology, I asked the students to read and present applications of algebraic topology to other fields of science of their choosing. We had several exciting conversations about the applications of knot theory to protein folding and data science. The notes and the student presentations can be found here: https://apurvanakade.github.io/courses/2017_h2g2_alg_top/index.html

2.7 Canada/USA Mathcamp

I taught at an intensive, residential, five-week summer camp for mathematically talented high school kids for five summers. The academic day at the camp is filled with classes, talks, and office hours with more than 100 courses offered each summer, covering material typically only encountered in college or grad school. My non-teaching duties included living in the dorms with students as an RA, being an academic advisor, and advising students on which courses to take. More information can be found here: https://www.mathcamp.org/jobs/grad_students/

- **Mentor:**

  I designed and taught week-long courses on advanced mathematical topics such as linear algebra, manifolds, Riemann surfaces, representation theory, and computer-assisted theorem proving. I also mentored several reading and coding projects. A defining feature of Mathcamp is that each student designs their schedule (with the guidance of an academic advisor). As such, the courses need to be designed to be interesting and challenging. In 2020, I had the added challenge of doing this online. For this, I created a hybrid coding/math course introducing students to computer-assisted theorem proving. Notes from my Mathcamp classes can be found here: https://apurvanakade.github.io/for-students.html#canadausa. Following is a list of some to the topics I taught:

  - Lean at MC2020
  - Crash course on linear algebra
  - Galois correspondence of covering spaces
  - From high school arithmetic to group cohomology
  - Cohomology via sheaves
  - How curved is a potato
  - Would I ever lie group to you?
  - Riemann surfaces
  - All things manifoldy

- **Academic Coordinator:**

  In the summer of 2017, I was one of the two academic coordinators at Mathcamp. The academic coordinators are responsible for designing and running all the educational activities, including inviting and hosting external visitors, preparing a balanced five-week class schedule (more than 100 classes), assigning (110) students to projects, teaching, and being a part of the hiring team. More information can be found here: https://www.mathcamp.org/2018/staff/

Chapter 3

Grants & Awards

3.1 Open Educational Resources Faculty Grant, NU 2022

I and Aaron Greicius received a $10K Open Educational Resources Faculty Grant at Northwestern University. The grant is for adding interactive WeBWorK, and SageMath exercises to Aaron's open-source Linear Algebra textbook available here: http://linear-algebra.northwestern.pub/frontmatter-1.html. We hope to make the book self-contained and a complete replacement for a standard linear algebra text. I have prior experience with WeBWorK which has helped us get started immediately.

3.2 Undergraduate teaching awards

- **William Kelso Morrill Award for Excellence in Mathematics**, JHU 2019

This award is granted by the JHU Mathematics Department each year to the graduate student who best displays a love of teaching, love of mathematics, and concern for students. Website.

- **Finalist for the KSAS Excellence in Teaching Awards**, JHU 2019

The award honors the best graduate TAs in the Krieger School of Arts and Sciences, JHU for the care and concern they take with their subject and their students. Website.

- **Prof. Joel Dean award for Excellence in Teaching in Mathematics**, JHU 2016

Annual award to recognize graduate students and faculty who have exhibited extraordinary performance in teaching undergraduates

3.3 AMS Graduate Student Travel Grant 2019

I was awarded a $250 travel grant by AMS for giving a talk at AMS Sectional Meeting

Chapter 4

Mentoring

4.1 Causeway Postbaccalaureate Program

I am a supplemental instructor for the Causeway Postbaccalaureate Program at Northwestern University for the 2022-23 academic year. My duties include meeting with the participants weekly as a tutor, holding office hours, and liaising with course instructors to provide additional examples, exercises, and reviews for the students.

The Causeway Postbaccalaureate Program is a yearlong experience in mathematics that seeks to increase the number of graduate mathematical science graduates from historically underrepresented groups. Beginning in July 2021, Causeway participants will undertake a rigorous program of study in foundational coursework; work closely with Northwestern faculty on an appropriate research project, and receive career mentoring while serving as mentors for other groups themselves.

4.2 Directed Reading Program

The Directed Reading Program pairs undergraduates with a graduate student/postdoc whose interests align with theirs and study a topic of their choice for one semester. It is intended to help motivated students explore topics more in-depth than possible in a classroom setting. I've helped start and organize the DRP at UWO. In the past, I have co-organized the DRP at JHU. These programs have been greatly successful at both the universities and have seen a steady increase in participants over the years.

Chapter 5

Professional Development

5.1 Project NExT

Mathematical American Association's Project NExT (New Experiences in Teaching) is a professional development program for new or recent Ph Ds in the mathematical sciences. It addresses all aspects of an academic career:

- Improving the teaching and learning of mathematics
- Engaging in research and scholarship
- Finding exciting and interesting service opportunities
- Participating in professional activities

This program provided me the opportunity to connect with and learn from other math educators from all over the country.

5.2 JHU Teaching Academy Certification

I have obtained a teaching certification from the Teaching Academy at JHU. The Teaching Academy's Certificate of Completion program is designed to help prepare Ph.D. students and Post-doctoral Fellows for academic careers and assist in acquiring a foundation for the teaching responsibilities associated with their first faculty appointments. This program exposed me to teaching as a scholarship and got me started in my current career as a math educator.

5.3 SIMIODE Workshop

I attended a week-long MAA Open Math workshop in Summer 2022 about teaching differential equations using a modeling first approach. This workshop was based on resources from SIMIODE (Systemic Modelling Opportunities with Differential Equations). The workshop was highly relevant as I will be teaching this course in Winter 2023. I intend to redesign it to make it more applied and incorporate projects in assessments. I also plan to use the newly published SIMIODE textbook as the primary textbook. The workshop was well-organized, and I learned a thing or two about how to run an excellent online program.

5.4 SIGMAA IBL

I have been attending SIGMAA IBL (Special Interest Group of the Mathematical Association of America for Inquiry-Based Learning) workshops since joining Project NExT. IBL SIGMAA aims to bring practitioners and others interested in IBL together to share teaching resources and experiences, encourage and publicize research related to IBL, and promote the proliferation of IBL in Mathematics through conversation and

professional development. I regularly attend their monthly talks about IBL teaching resources and experiences. This quarter I've started regularly attending the Online Seminar in Undergraduate Math Education covering similar topics.

5.5 Critical Issues in Math Education Workshop

I attended the CIME workshop at MSRI in Summer 2022. The workshop brought together teachers and researchers from universities, community colleges, and K-12 schools. The goal was to explore the reasons for and processes by which change in university mathematics departments is initiated, promoted and sustained and lessons learned from change efforts in K-12.

5.6 Northwestern Excellence in Teaching Alliance

From 2021-22, I participated in Northwestern's teaching alliance program. The program provided reading resources and guides through a Canvas course hosted by the Searle teaching center at Northwestern. We met in small cohorts monthly to engage in conversations led by a faculty peer around teaching and learning.

5.7 Mastery Grading

In Summer 2019, I participated in a workshop on mastery grading. During the workshop, we learned about standards-based grading, and we heard about how it has been implemented across a variety of courses. I am considering implementing this grading system in the Intro to Proofs course I'm teaching in Winter 2023.

5.8 Science of Learning Symposium, JHU

I attended a biennial Science of Learning symposium at JHU from 2014-18. The event brought together experts in cognitive science, neuroscience, education, and other fields to explore different perspectives on the cognitive and neural bases for learning and motivation. I found the insights about the physiological basis of learning to be very helpful. I have since read more about these topics and completed the "Learning how to learn" course on Coursera.

Chapter 6

Teaching Evaluations

6.1 Student Evaluations

The following table lists *median* scores for the questions of **Instructor Effectiveness** and **Course Experience** from end-of-course student evaluations. Detailed student responses can be found here: https://github.com/apurvnakade/PDFs/tree/main/teaching%20evaluations

		Instructor	Course
2022 Spring	Introduction to Optimization	6/6	6/6
2022 Spring	MENU Linear Algebra and Multivariable Calculus	6/6	5/6
2022 Winter	MENU Linear Algebra and Multivariable Calculus	6/6	5/6
2021 Fall	MENU Linear Algebra and Multivariable Calculus	6/6	6/6
2021 Fall	Single Variable Calculus (coordinated)	5/6	4/6
2020 Fall	Discrete Structures for Engineering	7/7	7/7
2019 Fall	Calculus I for Mathematical and Physical Sciences	6/7	6/7
2018 Fall	Honors Single Variable Calculus	5/5	4/5
2017 Summer	Differential Equations with Applications	5/5	4/5
2015 Summer	Differential Equations with Applications	4/5	4/5
2014 Summer	Online Linear Algebra	3/5	3/5

6.1.1 Selected Student Feedback

- This[Optimization] was the best math class I've taken so far at Northwestern. For the first time, I feel like I will carry the material I learned in class for years and years, as it's so applicative to real world problems.
- Optimization is a really useful and practical math course that all math majors should take. It isn't very proof-heavy and focuses more on computation.

- Apurva is phenomenal! He broke down key concepts with ease, and homework questions went over a variety of different examples. Optimization is interesting as a whole due to it wide applicability in other fields, but I felt this was an enjoyable course because of Apurva
- Dr. Nakade is the best teacher for second-year software engineering. Your recorded lectures are very clear and make me happy as I actually understand after watching them. You seem like a very hard-working professor that truly cares about their students. Thank you! The zybook and PA and CA are just perfect for making me on-track. I'm never behind in this class because of the PA and CA.
- The PAs and CAs are helpful and fun and an interactive way that helps me learn the concepts better. I like that I am not punished for when I get an answer incorrect and am instead presented with the

solution so I can better understand it while learning. The webworks assessments are also a good and fair evaluation of my understanding (Also, thank you for not using Proctortrack because the idea of it really stresses me out.)

- The use of ZyBooks to teach discrete math was an absolute genius move, as the online textbook paired with the instructor videos were extremely clear in explaining and testing knowledge of mathematical concepts. I recommend using it for future years
- Apurva is the best Professor. Though his lecture notes can have minor mistakes, he is a very nice guy and you can ask him questions without being intimidated. His office hours are very helpful and talking to him about non–math things are also a lot of fun.
- Professor Nakade is so kind and enthusiastic about helping his students learn. This quarter of MENU was definitely challenging (like the other two), but there is a strong system of support from office hours and studying with MENU friends that makes the course doable.
- Apurva is very encouraging when you are struggling with a problem and you can really tell that he was excited about math and teaching!

- He is really passionate about the subject and explains things well. He is very funny and approachable in class, and he gives a lot of opportunities for students to "check their understanding" by participating in class, working through problems as a class, etc. He also would always stay after class for questions if anyone had any.

6.2 Peer Evaluations

In Winter 2020, I participated in the Teaching Mentor Program at UWO. The Teaching Mentor Program is a cohort-based hands-on learning experience, wherein participants work with a group of 4-5 interdisciplinary graduate students and postdoctoral scholars to observe and offer feedback on one another's teaching. Groups will meet multiple times over the course of the semester, to act as students in one another's teaching demonstrations. My group had four participants whose feedbacks are attached here.

Western Science

Statistical & Actuarial Sciences

Dr Kevin Granville
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March 25, 2020

Dear Colleagues,

I am writing this reference in support of Dr Apurva Nakade, a fellow postdoctoral associate working at Western University. As a part of the Teaching Mentor Program offered by the Centre for Teaching and Learning, I observed Dr Nakade conduct a Calculus 1501B lecture for approximately 100 students on February 24, 2020.

Dr Nakade made use of a whiteboard in his lecture. Through the combination of clear writing, coloured markers, and good board practices (e.g., separating important information within boxes, separating portions of boards with vertical lines), I found his material very easy to follow. Something that stood out to me was that he carried no personal notes and everything he wrote for the students was from memory or improvised, clearly showing his mastery of the subject matter.

Dr Nakade also demonstrated great interactions with his students. Frequently throughout the lecture he would pause and prompt the class for any questions that they may have had. Despite the large size of his class, he responded to students by name, which was very impressive. After answering a particularly important question, he wrote the answer down on the board so that nobody in the class would miss it. Throughout the lecture, when Dr Nakade asked his students questions, there were no issues having them participate and provide their thoughts. Following the conclusion of the lecture, he remained in the classroom to answer any remaining questions from his students.

Having personally taken dozens of courses in Mathematics and Statistics, it is my impression that Dr Nakade is off to a strong start as a lecturer and will continue to improve as he continues his career in academics. If you have any further questions, please do not hesitate to contact me.

Sincerely,

Kevin Granville

Kevin Granville

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Western

Date: 19 March 2020

Dear Colleagues,

I am writing this letter to comment on the teaching practices of Dr Apurva Nakade. I observed Dr Nakade give a lecture as part of first year level Calculus course on the 5th March 2020. This lecture was part of the Teaching Mentor Program that is offered through the Centre for Teaching and Learning at Western University. The lecture was presented to a class of approximately 100 students, who were in their 1st year of undergraduate degree.

Dr Nakade employed an excellent combination of teaching methods, including the use of the white board to solve equations. The lecture content was organized in a very logical and easy to follow format, with seamless transition between theory, examples and answering student questions. I was especially impressed by the level of student engagement and how much students were encouraged to ask questions. Furthermore, Dr Nakade showed excellent interaction with the students, as seen by him referring to them by name and being clearly familiar with their level of knowledge. I was especially impressed by how Dr Nakade used his familiarity with the students to ensure questions are answered by different students and more people in the class had the opportunity to participate.

I observed a great relationship between Dr Nakade and his students, with open communication and feedback on how equations should be solved. He also clearly embraced suggestions for alternative solutions, but also emphasized the benefits and drawbacks of the alternative methods. I was delighted to see Dr Nakade bring in previous lectures and specific examples of equations that are needed for the current material to be analysed and focusing on key concepts.

Overall, I found the lecture I attended to be very well planned and executed, with a great balance of active learning components and real-life applications.

Sincerely,

Dr Mariya Goncheva
Postdoctoral associate
University of Western Ontario

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To whom it may concern,

I am writing this letter to comment on the teaching practices of Dr. Apurva Nakade. I attended a lecture that Dr. Nakade taught on Calculus, a basic algebra lecture. This lecture was presented during a peer-review process as part of the Teaching Mentor Program that is offered through the Centre for Teaching and Learning at Western University. The lecture was presented to a class of about 50 undergraduate students.

Dr. Nakade employed an excellent combination of teaching methods, mainly usage of the board, as the most appropriate way to teach mathematics. He created a learning environment that was very engaging and supportive, properly for undergraduate students. The lecture content was organized in a very logical and easy to follow format, with an excellent transition between theory, examples and answering questions. I was especially impressed by his ability in knowledge transformation and his comfort with the topic. It was amazing how he explained a new abstract concept in simple words and with many examples, which were quite understandable for the audience.

Dr. Nakade very well handled many questions after every step. His responses were very clear step-by-step solutions. So, he ensured each student received an opportunity to contribute in a very welcoming atmosphere without getting anxious. In other words, Dr. Nakade made the subject understandable and interesting to those with little formal or technical training in algebra.

Overall, I found the lecture I attended to be very well planned and executed, with a great balance of active learning components. I believe he would be an asset in any teaching role.

Sincerely,

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Appendix A

Sample Teaching Materials

A.0.1 Introduction to Optimization course materials

A.0.1.1 Course notes

https://apurvanakade.github.io/Introduction-to-Optimization/

A.0.1.2 Syllabus

https://canvas.northwestern.edu/courses/164403/assignments/syllabus

A.0.1.3 Sample worksheet

Problem 4. Baseball elimination.

There is a league consisting of several baseball teams. At any point during the season, *a team is eliminated if it cannot possibly finish the season in first place or tied for first place.* The goal is to determine exactly which teams are eliminated. The problem is not as easy as you might first think, in part because the answer depends not only on the number of games won and left to play, but also on the schedule of remaining games. To see the complication, consider the following scenario:

			Against			
Team	Wins	Left	Atlanta	Philly	New York	Montreal
Atlanta	92	2	-	1	1	0
Philly	91	3	1	-	1	1
New York	91	3	1	1	-	1
Montreal	90	2	0	1	1	-

Montreal could finish the season with as many as 92 wins, which appears to be enough to tie with Atlanta. But this would require Atlanta to lose both of its remaining games. In this case, Philly and NY will have at least 92 wins. But they also have a match left between them and so whoever wins that match will end up with 93 wins. So, Montreal is also mathematically eliminated!

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Consider the following scenario:

			Against			
Team	Wins	Left	Atlanta	Philly	New York	Montreal
Atlanta	83	8	-	1	6	1
Philly	80	3	1	-	0	2
New York	78	6	6	0	-	0
Montreal	77	3	1	2	0	-

Note that this time Montreal is easily seen as being eliminated (Why?). Write and solve a linear program to determine if New York is eliminated. (Instead of finding an optimal solution, you're trying to determine if there is a feasible solution to the linear program.)

Write and solve another linear program to determine if Philly is eliminated.

You do not have to run Phase I when using Solver in Excel. You can create a constant objective function and ask Solver to find an optimal solution.

A.0.2 Discrete Math course materials

A.0.2.1 Video lectures

https://www.youtube.com/playlist?list=PLXAOfwfSuiKm3cL-JftD9ndrjYi7fPcqN

A.0.2.2 Discussion forum

https://piazza.com/demo_login?nid=kd1rr8nxc6z4b5&auth=f76e59e

A.0.2.3 Rubric for grading proofs

Rubric for homework - Math 2151a

Trait	Does not meet (0)	Attempted (1)	Approaches (2)	Meets (3)
Quality of upload	None of the 3 criteria are met.	1 of the 3 criteria are met.	2 of the 3 criteria are met.	All of the following 3 criteria are met: Solution starts on a new page and is uploaded properly. If handwritten, a dark pen/pencil is used and the handwriting is clear and legible. Document is correctly oriented and properly cropped.
Interpretation of Problem	Complete misinterpretation of what is given or what is to be shown. In this case, you get a 0 in all of the traits below.	Correct but incomplete interpretation of the problem. May overlook significant details in the statement of the problem.	Correct interpretation of the problem but the hypothesis (given) and conclusion (to show) are not clearly stated.	Correct interpretation of the problem with the hypothesis (given) and conclusion (to show) clearly stated.
Details	Virtually no relevant details are present. In this case, you get a 0 in all of the traits below.	Additional relevant details are needed to develop most points.	All points are developed, but some may need additional relevant details or some excess may be present.	All points are supported by a sufficient number of relevant details with no excess.
Reasoning (proof)	The logical connection of the argument is weak, leaving the argument or explanation unclear. A "proof by example" falls here.	The reasoning offers apparent support for the argument, but the argument or explanation is weak.	Collectively, the logic offers adequate support for the argument, but the argument or explanation remains unclear or incomplete.	Collectively, the logic supports and advances the argument or explanation of the proof.
Word Choice and Terminology	Word choice or terminology is consistently inaccurate or inappropriate; many words or terms are notably misused.	Word choice or terminology is vague, limited, or repetitive, reflecting a weak grasp of the language appropriate to the proof.	Word choice and terminology is generally accurate, but reflects a partial or inconsistent grasp of the language appropriate to the proof.	Word choice is consistently appropriate and terminology is accurate, and reflects a strong grasp of the language appropriate to the proof.

A.0.3 Other course notes

A.0.3.1 Course notes for *Honors Single Variable Calculus*

https://github.com/apurvnakade/jhu2017-18-honors-single-variable-calculus/blob/main/2018/output/ClassNotes.pdf

A.0.3.2 Course notes for *Theorem proving using Lean*

https://apurvnakade.github.io/mc2020-Lean/

A.0.3.3 Canada/USA Mathcamp and other notes

All of my teaching materials can be found on my website: https://apurvanakade.github.io/math-notes.html