# TEACHING PHILOSOPHY

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The framework that permeates my teaching and service is the use of experiential learning to highlight the humanistic nature of mathematics, as well as the benefits of collaborative inclusive communities for mathematical innovation and discovery. Experiential learning is learning through reflecting on doing, or learning through experience. As a graduate student at the University of Iowa, my approach within this framework focused on experiential learning through inquiry and flipped instruction. I completed a teaching practicum where I worked with an instructor to develop an inquiry-based learning (IBL) workbook for her discrete mathematics course. I also developed a teaching as research (TAR) project through the Center for the Integration of Research, Teaching, and Learning (CIRTL) at UIowa to study the utility of instructional videos on students' perceptions of their own learning. I used a 'partially' flipped method to teach a trigonometry course, where students watched instructional videos that I created before class one day a week which were coupled with video quizzes to be completed before class. During the flipped instructional period we reviewed the content from the video and then participated in active learning activities through worksheets, groupwork, and games. One of the most well received activities was called Top Chef Grapher's, a spoof on a popular cooking show where students had to create a `meal' in teams given certain `ingredients' such as sin(x), amplitude of 5, phase shift of $\pi$, etc. After creating the meal (writing a correct function), the students had to present it to be judged (draw an accurate graph and describe its features). Students commented on how fun that lesson was for several weeks and in course evaluations.

At Ohio State I gained more experience with flipped instruction by teaching Calculus Flipped & Flexible for two semesters, where students watch lecture videos created by the department three times a week, and attend a recitation in-person twice a week. We made use of a room lined with chalkboards on three walls to have small group and whole group discussions about course concepts presented in the lecture videos. While this flipped instructional setting was familiar to me as an instructor, transitioning the following semester to a recitation assignment for the PhD level Algebra sequence at The Ohio State provided new instructional opportunities. The graduate students did not need to be motivated to engage with the course material in the same way that calculus students did, but instead needed the material itself to be motivated. Simply put, they wanted to know `why' and how. They were constantly looking to add to their toolboxes with an insatiable curiosity that was new to me as an instructor, but extremely inspiring. Within this teaching assignment I was able to stretch myself as an educator, and also mathematician, by working to contextualize the topics we covered each week within the greater research landscape. It was especially exciting to do this by integrating my own research into our recitation discussions. For example, I gave a mini lecture on factorization theory and the motivation for studying non unique factorization after discussing Gauss' Lemma.

I worked to turn our recitation environment into a collaborative space using group-based discussion and activities. In the calculus recitation we used WikiStix (malleable waxed yarn sticks) to sketch the first and second derivatives of a function, whereas in the recitation with the PhD students we used WikiStix to review symmetries of the dihedral group before talking about the presentation of a group. I made it a point to have students present homework problems at the board instead of working them myself, which is the standard at our institution for these types of recitations. Eventually some began to volunteer, even if they were unsure, as they knew their peers or myself would provide input in places where they might get stuck. At the beginning of the academic year, we began to clap each time a student presented a problem, even if incomplete, and soon this response was a normal (pleasantly loud) part of our course. I received emails each semester from several students, noting that our recitation was one the most enjoyable parts of their week due to its collaborative nature. I was also thanked for providing feedback on nontraditional approaches to proofs in the problem sets.

Recently, I have embedded experiential learning into curriculum design through the development of the first service-learning course offered by the Department of Mathematics at The Ohio State University, "Intersections of Mathematics and Society: Hidden Figures" with my colleague John H. Johnson, Jr. This course was inspired by the text, Hidden Figures: the American Dream and the Untold Story of Black Women Mathematicians Who Helped Win the Space Race by Margot Shetterly, which was turned into an award-winning film of the same name. In this course, we directly addressed the connection between the creation of mathematics, its developments and applications, and society. The course featured many instances of embedded reflection, which was one of several design decisions rooted in the three pillars of culturally competent pedagogy: (1) academic achievement, (2) cultural competence, and (3) sociopolitical consciousness. While (1) is a staple of all pedagogical methods, (2) and (3) are less common. Consider the following discussion board prompt: *In Chapters 5 and 6 of Hidden Figures, we are introduced to the West Area Computing Group where Dorothy Vaughan works alongside other black women mathematicians at NACA. In this post, explore the intersections between mathematics and society by discussing the need for rapid growth in the scientific and research community juxtaposed with the social and legal enforcement of segregation.* This addresses each of the three pillars. We based our Friday in-class conversations on students responses to the online reflections, and we found that this greatly

added to a sense of community in our course and allowed for the modeling of appropriate ways to engage in intellectual discourse related to diversity and inclusion in mathematics. An article about the course and on these instructional practices will appear in the Early Career Section of the Notices of the American Mathematical Society in 2021.

As evidenced by the above discussion board prompt, a major goal of the course was to critically examine the historical intersections of race, gender, and mathematics by centering the *Hidden Figures* text and the scientific community during the Space Race, and a significant portion of the course was devoted to exploring the role of mentorship and community within the mathematical success. We examined the role of advocacy and support in the career trajectories of the primary characters in the text through weekly discussion board posts and in-class conversations. We also encouraged students to reflect on their own experiences in STEM, and several were inspired by the resiliency demonstrated by the women in the text. One student shared in class that her advisor told her she should not be a math major after a rough first semester freshman year, leading her to feel like she did not belong in the major. Since then she had motivated herself by aiming to prove her advisor wrong. In a particular online reflection she noted,

*"The entire story has completely reshaped [my] look on life in STEM…Every day in this class and every week after reading the chapters, I would get a surge of "math adrenaline," and I had the realization that I loved math, I just hated the community I was a part of originally. Reading this book and being in class is the first time in 3.5 semesters that I finally felt like I belonged in STEM and I could do great things in the community."*

Another key focus of the course was understanding mathematical innovation through the exploration of mathematical tools. In-class students learned how to operate engineering grade slide rules, computing devices utilizing a logarithmic scale to perform operations ranging from multiplication and division to hyperbolic trigonometry. The technical study of this tool was made richer by understanding its use in the scientific community during the Space Race. For the service-learning portion of the course, students developed STEM kits for local library branches that would teach students how to use slide rules, and also about the women in the *Hidden Figures* text. The students also interacted with local Hidden Figures, STEM professionals from underrepresented backgrounds in the Greater Columbus Metro community. In addition to learning about the personal backgrounds of the Hidden Figures, students learned about the specialized mathematical tools used in their work. Students learned about the Catia 3D software and mathematical modeling tools used at Honda Manufacturing. They learned about specialized tools to analyze data such as logistic regression, data visualization, mathematical modeling, R, and Python used at JP Morgan Chase. They also took note of the ways that statistical analysis and excel can be used to communicate and sort data for reports generated by the Franklin County Coroner's office. These experiences helped illuminate ways that our students could use their quantitative training in settings outside of academia.

Work on this course organically led to an interest in the `hidden' stories of Black mathematicians at Ohio State, and in particular, their mathematical legacies as an educational tool. I am the PI for an internal grant [that is currently under review] which will allow me to lead an interdisciplinary research project with the National Afro-American Museum and Cultural Center of the Ohio History Connection, along with faculty, staff, and a student research team to create a digital archive of Black mathematicians from Ohio State. We have discovered nearly 200 mathematicians who have earned degrees from The Ohio State who identify as Black. These individuals have gone on to become prolific researchers, high school teachers, economists, book authors, lawyers, and university presidents. Many of these pioneers have stories intimately linked with the history of the institution, Columbus, and the state of Ohio, yet nearly all remain "hidden figures." Our interdisciplinary storytelling team features faculty and staff with expertise in Mathematics, English, Strategic Communication, and Photojournalism, and together we will highlight these untold narratives and provide historical STEM educational resources for the greater Ohio community. I will supervise a small student team to focus on identifying and communicating the mathematical contributions of the individuals in our case study. For example, the first Black American to obtain a PhD in mathematics from The Ohio State was William McWorter, Jr. In addition to his work in fractal theory, he wrote two papers that produced algorithms for computing the characteristic polynomial and eigenvectors of a matrix without using the determinant. I recently spoke to the undergraduate math club about his methods in a talk entitled, "Death to Determinants." I believe an investigation of determinant free methods in linear algebra could form the basis for an exciting undergraduate research project as an extension of this work.

My teaching practices and projects relate directly to my career mission statement, which is to increase access to mathematics for Black Americans and other members of traditionally underrepresented groups in the mathematical sciences, and to facilitate the training of the next generation of STEM leaders who embody the core belief that service is a part of science. I strongly believe that creating equitable, collaborative, and humanistic learning environments will positively influence students in the mathematical sciences from all backgrounds. I aim to continue facilitating interdisciplinary research opportunities for students, and creating connections and collaborations between the academe and local communities. My recent work has led to an interest in the use of primary source documents to create inclusive classrooms and curricula, and I look forward to pursuing new pedagogical frameworks to shape my teaching.