Teaching Statement

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The primary roles of a faculty member are to educate and advise students and to conduct research. To achieve success in the former, I focus on teaching logical reasoning, using a teaching style that helps students become confident in math, mentoring students through their academic career, and by conveying that I care about their success as a person. I also have experience teaching math educators and mentoring students in research projects.

I have taught mathematics at four different schools, a large research institute with undergraduates, two small liberal arts, and a graduate only research institute in Japan. Each gave me new perspectives on education and valuable experiences. The first place I taught was in graduate school at the University of Nebraska-Lincoln, a large state university, where I was the sole instructor of many classes over my five years there. UNL is where I learned that I truly love to teach. After I graduated, I took a one year position as a Visiting Assistant Professor at Gettysburg College, a small liberal arts school, and taught three classes each semester. Here, I realized that teaching a new course for the first time was exciting and made me learn more than I thought possible. I also discovered that I felt the most at home at a small liberal arts college. Next, I took a Postdoctoral Scholar position at Okinawa Institute of Science and Technology Graduate University in the Topology and Geometry of Manifolds Unit. At OIST, there are only graduate students, so the teaching dynamic is very different, with significantly more mentoring than traditional teaching of classes. This helped me to appreciate the different kinds of challenges that arise when leading students in research projects. And I am now currently at Colby College, a small liberal arts college where I get to be back in the classroom. Most importantly, each of these schools provided the constant opportunity to share my knowledge with students as well as learn from the process just as much as them.

In this statement, I will give examples of my experiences at each of these schools to illustrate how I teach, but I want to first say that I take a very pragmatic approach to teaching. To make this point, I always remind myself that universities do not exist for educators to teach, but for students to learn. This is somewhat of a subtle difference, but it keeps me open to changing my techniques as is needed, to be sure my students are learning.

The University of Nebraska-Lincoln does a marvelous job at preparing mathematics graduate students to be effective teachers. This is from the immense support they provide and the wide range of classes graduate students teach, often as the sole instructor. I started out leading calculus recitations and then I became an instructor of record in college algebra, trigonometry, calculus I lecture, and mathematics matters. Over the summers, I was a teaching assistant for NebraskaMATH, which I will expand upon later. The support that they provide ranges from a pedagogy class, workshops before each year, and every course has a faculty member or senior graduate student who organizes the common elements and will answer any questions the other instructors might have. I am very comfortable and confident in the classroom because of my time at Nebraska.

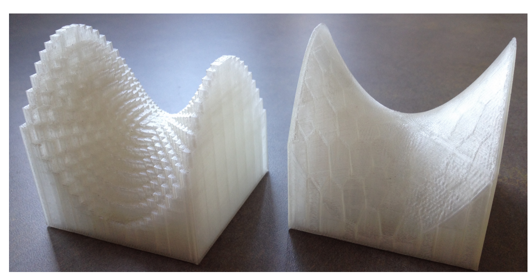

Figure 1: A 3D print I designed of an integral of a saddle point surface and a Riemann sum approximation.

When I started teaching at UNL, I was primarily teaching in lecture style, since that was how I was taught. I soon had many students coming to me with the same issue that we have all heard, “I understand it during class, but when I go home, I don’t know where to start.” I realized that it sometimes was not enough to show students how to do the math on the board if I wanted them to be successful when they left the classroom. I began to insert more time during class for students to work on the problems themselves or in pairs. There is, of course, a drawback, which is they see less problems worked out in class. But I feel that the students still benefited more from the practice time. This precipitated my switch to a more active classroom rather than lecture style, where I walk around and answer questions and give feedback, especially for the pre calculus classes. During my last year at Nebraska, they switched to a flipped classroom style for all its pre calculus classes. A flipped classroom is one where the students are expected to read the sections that will be covered before they come to class or watch some tutorial videos. Then the whole class time is dedicated practicing the content they read, guided by the instructor. Students will write solutions on the board and get feedback from other students as well. I believe this greatly increased the performance and understanding of the students.

I find it beneficial to add in more hands on experiments to my classes. For example, in my trigonometry class, I have a particular lesson I give when discussing rotational velocity versus linear velocity. Students usually know the basic speed formula, $s = d/t$, where d is distance and t is time. They are probably not so well acquainted with angular velocity, how many radians an object rotates per unit of time. Once they know the angular velocity, if we know the radius of the circle that the point is traveling along, we can easily convert to linear velocity, by multiplying by the radius. But I like to make the students more involved when I can. I bring a rope with a weight attached to the end to class, and I have someone time me for ten seconds while I spin the rope as fast as I can. The rest of the class counts how many full revolutions I can make in that time. Using the amount of revolutions and time, we can compute the average angular velocity. I measure the rope to find the radius for them, and we get to find out how fast the weighted end is moving in linear velocity. We can achieve a linear speed of about 50 feet per second, which impresses the students. The students learned this lesson better than most because of the unique style and change of the pace of the lesson and I learned I can get rope burn in less than ten seconds. I bring gloves when I teach angular velocity now.

During the summers of graduate school, I taught for the NebraskaMATH program. The goal was to better educate teachers across the state, and thereby increase the proficiency of the students they are teaching [1]. It was wonderfully well attended and involved more than 700 teachers from all over Nebraska. I was involved in all three divisions over my time there and it gave me an appreciation for how difficult it is to teach the most fundamental concepts in mathematics. We don’t think about how we add anymore, for example, so verbalizing what we actually are doing is challenging. It is even more challenging when each student has a different way of thinking about it themselves, and the educator must be able to quickly switch between the students’ methods of solving a problem.

The last item I want to share from UNL is the 3D printing seminar I established. I became interested in 3D printing when I wanted to better visualize immersions of surfaces in 3-space. But what I found was that I was woefully ill-equipped to produce the objects that I wanted to hold in real life. So I spent a lot of time learning how to use a 3D modeling program and am now very proficient using it. Realizing how much I could do to help explain mathematical concepts with a 3 dimensional model, I started building objects to assist my teaching. Graduate students, faculty, and even some undergraduates were interested in designing and building models, so I decided to start a workshop, to teach anyone how to use the software. It became a full fledged workshop and I designed and gave lessons about how to build a wide variety of models. It is particularly exciting to use the programing language python in conjunction with the 3D modeling software, which allows us to graph 2D and 3D models quickly and easily. Not only does 3D modeling and printing allow us to further our research, like my initial reason for learning the software, but it opens up a whole new range of teaching aids that will deepen the understanding of my students like no picture on a blackboard can. Figure 1 is an example of two related prints, one the Riemann sum approximation of the integral of a surface and the actual integral. With some effort, the students can be the ones to design and create these models themselves. They would learn about 3D modeling and apply it to a mathematical concept, which will deepen their understanding and get them involved in ways they might not otherwise. I also have a web-based version of this available on my website, `http://nick.owad.org`, titled "Automating .stl files," where anyone can change the surface that we are integrating over. I hope to continue sharing my knowledge of this new technology and look forward to creating more tools for anyone to use.

Next, I taught at Gettysburg College, where I was part of an amazing department and was able to see how a small liberal arts college approaches education. The attention to each student's success is paramount and is regularly on display as faculty go out of their way to assist students in much more than just the classroom. I truly enjoyed teaching there and know that it is the kind of environment which not just students thrive, but the faculty as well. While at Gettysburg, I taught three sections of Calculus I in the Fall and two sections of Calculus II and Differential Equations in the Spring. This was the first time I was able to spend a year with a lot of the same students as they followed the calculus sequence. Having the same students allowed me to tailor my lessons to their strengths and weaknesses.

Having repeat students who knew me also afforded me the chance to try something new with the one section of Calculus II. There were only about 12 students one of my sections, which allowed us to have much more in depth discussions. I turned the first half of the course into a semi-IBL style classroom. IBL stands for Inquiry Based Learning, a teaching style where the students learn from their own discoveries, rather than me lecturing. Most days, I would spend five minutes at the board to set up the discussion, and the students would fill in the rest of the lesson themselves. Throughout the lesson, I asked questions and gave some hints or corrections to push the discussion in the right direction. The students would take turns at the board and be assisted by the rest of the class. It was really rewarding as a teacher to see them have lengthy debates about Riemann Sums, integration by parts, and so on, fueled by their own curiosity. Part of what made the semi-IBL method a success was the small classroom size, making everyone have to participate. The other section of Calculus II had about 25 students, and I do not believe IBL would have been as successful as it was for my smaller section.

While at Okinawa Institute of Science and Technology I did not teach the traditional sections of undergraduate courses, but was mentoring graduate students and visiting interns and co-teaching research level classes. The graduate students are often not classically trained in mathematics, but in another science. When I gave a series of lectures on knot theory, I used the applications of knot theory as a hook to engage the students, since that is where their interests lie. Then I worked toward how the theory can be used to further the applications. For instance, there is a large number of biologists here, and DNA can knot itself randomly. Before DNA can replicate, which it does often, it needs to be unknotted by special enzymes. By looking at the before and after of these enzymes attaching, researchers can start to guess what the enzyme does in general.

I was lucky enough to mentor two different undergraduate mentees and two graduate students while at OIST. From the mentoring I did, I have co-authored one paper with an undergraduate in knot theory, which is submitted to be published, and am still working on a project and paper with a graduate student in applying math neuroscience. One undergraduate student came to OIST without having ever studied knot theory. We worked through some of the basics and I taught him enough to understand an idea I had for a paper. This involved teaching him how to use specialized software to analyze the geometry of 3-manifolds and some python coding, in addition to the math. From here, he was able to implement an algorithm which exactly computed a knot invariant of almost 1800 knots, which was previously unknown! Obviously, I am exceptionally proud of his accomplishments. He further impressed me by writing up the work with me in a paper [2]. He plans on attending graduate school after graduating.

I am now teaching at Colby College. I am very happy to be back in the classroom. In the Fall semester, I am teaching two sections of an accelerated calculus I class. Colby has an initiative to bring more first generation college students to Colby, a goal I completely support. This means that there is more diversity in the classroom, including more varied socio-economic status, racial diversity, and mathematical background. To continue to provide the best educational experience possible, I need to reach a broader audience than before. So I spend more time making sure everyone gets to practice the material and has access to me during office hours. I encourage peer to peer collaboration in class and get them to explain things to their neighbors. Perhaps the biggest point I try to make to my students is that it is okay to be wrong. We want mistakes, so we can learn from them. And all that we lose is some space on the board or a piece of paper.

There is a higher stress level that comes with accelerated classes also. We expect students to deal with a huge range of new experiences when they enter college and we need to be aware of their mental wellbeing. I am careful not to forget that these students are dealing with a number of academic as well as non-academic issues. But I will never be aware of them if my students don't tell me. I always ask students how they are doing in life and in all their studies when they talk to me and, most importantly, I listen to them then. And I strive to ease their stress by letting them vent if they need to. In the same way, I make sure I am not overloading their schedules and make adjustments if need be. While I obviously consider their mathematical education important, there are more important things to them at times. Colby has a very effective system to deal with this and checks up on all their students to make sure they are thriving and not merely surviving.

I enjoy teaching. I feel that I am well suited to teach as I am very outgoing and personable. I do everything I can to make sure my students know that I want them to succeed in my class and in their goals in life. When they know this, they are more willing to open up to me about the things that they care about, class work or otherwise. Building a rapport with my students starts on the first day, when I tell them that I will help them whenever they want, but they need to put in the same amount of effort. I am always trying to become a better teacher. Teaching should not be a one sided relationship, it should be more of a conversation. To facilitate this, I communicate with them in a way that is more informal than they might be used to. I tell jokes, ask about their weekends, and wait for them to respond when I ask questions in class. Once students realize that I want them actively involved in the regular workings of the class, they are more willing let me know what they think will improve the class. I take an informal survey about a month into each class and ask them what they want me to change and I respond to their requests – telling them that I am going to take their advice, or explain why I am not going to. I believe this openness about how I teach and why I teach in the way I do has led to my teaching evaluation consistently being above average.

As educators, our ultimate goal is that our students learn. Doing everything in our power to work toward this is what will produce logical reasoning, confident students, and students who are willing to communicate with us. Ultimately, it will produce graduates who are more prepared to be successful in any pursuit in life.

References

[1] Center for Science, Mathematics and Computer Education.
University of Nebraska-Lincoln - `http://scimath.unl.edu/nebraskamath/`

[2] Felipe Castellano-Macías, Nicholas Owad, *The tunnel number of all 11 and 12 crossing alternating knots*, preprint. `https://arxiv.org/abs/1908.01693`