Kenneth DeMason
The University of Florida

I have always excelled academically and been inclined towards math, but it was only half a year ago that I discovered I have obsessive compulsive personality disorder (OCPD). It comes with an inherent desire to be perfect, an excessive devotion to work, and a fixation with minor details. Although I can now easily attribute my academic success to these personality traits, having them comes at a great cost. For one, I place an unbearable standard on myself which often generates uncontrolled anxiety. I, despite being good at math with a 4.0 GPA, have the stereotypical "math anxiety," and it has taken an incredible amount of self-work to mitigate it.

Math presents itself in school as a medium through which problem-solving skills are taught. Many students often question whether they will use advanced math in their everyday lives. While possible, it misses the underlying reason for teaching math. By shying away from math, students miss out on developing key logical foundations to solve practical problems.

My career goals are twofold. First, I aim to complete a Ph.D. in Geometric Analysis. Geometry captured my interest since it is one of the few visual domains of math; it bridges a large gap between high level math and easy, intuitive explanations. Second, I plan to use my research and status as a mathematician to help those with math anxiety and teach them that it is possible to overcome it. To that end, I will use geometry's visual nature, since it is less intimidating than algebra-based math.

Intellectual Merit: I first became very interested in math in high school. As a student in the International Baccalaureate (IB) program, I wrote a math paper on a way to approximate the inverse of $y = x^x$. It turned out that this was just a centuries old formula in disguise, but the process of finding what I thought to be my own method was fascinating. I continue to enjoy solving a variety of small problems and learning independently.

Throughout my time at the University of Florida, I have taken the most challenging courses possible. Starting as a math and biochemistry double major, I jumped into accelerated classes. In my first semester, I took Honors Calculus III and an advanced, one semester general chemistry course and as a sophomore I took the enhanced organic chemistry sequence.

At that point in my life, I was at a crossroad. While I was good at biochemistry, I was not very passionate about it; on the other hand, I was passionate about math, but lacked confidence. At the urging of my Honors Calculus III professor, I decided to take a risk and see if I could handle graduate analysis. I initially had reservations about moving directly into it, since analysis is often regarded to be one of the harder fields of math. Despite this, as a junior, I skipped the undergraduate analysis sequence, went into graduate analysis, and excelled. It is largely because of this that I made the decision to focus on math rather than biochemistry; succeeding in graduate analysis taught me that I can handle the rigor of graduate coursework.

Although I am focusing on math, biochemistry served as an important gateway into my research career. The physical chemistry and biochemistry research I started in January 2017 has taught me several valuable lessons. Most importantly, teamwork is essential. Make protein and buffers in excess so everyone can use some. Help someone out when you have time and they do not; they may return the favor later. While my chemistry knowledge will not directly help in my pursuit of a math Ph.D., these important research skills easily translate to any field. Biochemistry also opened me to my first real teaching experience. I became a TA for the advanced general chemistry course, and it confirmed my love of teaching.

In Fall 2018, I began my first math research project on minimal surfaces. I investigated the catenoid, the only minimal surface of revolution. After finding a simple proof of this property, I discovered another property unique to the catenoid not found in the literature. Then, I extended a formula from normal vector fields to general smooth ones. I enjoyed these topics because they were questions I proposed myself and was later able to solve, and they provided an important foundation for working with surfaces.

These projects motivated me to complete the graduate analysis sequence, take a special topics course in curves and surfaces, and study from do Carmo and Montiel & Ros on my own. My research experiences led me to be named one of UF's four nominees for the prestigious Goldwater Scholarship in the 2018 and 2019 cycles. This year, I am enrolled in all graduate math courses, most of which are taken by mature graduate students. Furthermore, my undergraduate thesis is supported by $2500 of funding and $500 towards conference travel payment as part of UF's selective College of Liberal Arts and Sciences Scholars Program. I have recently been named one of UF's two nominees for the Churchill Scholarship.

In June 2019, I attended Princeton's Summer School in Geometric Analysis to gain knowledge outside my home institution and to evaluate the graduate program that interests me the most. About 30 students were admitted to participate in a three-week, 32 lecture program. The lectures focused on several important topics in geometric analysis, greatly enhanced my knowledge in the field, and showed me how deep and active of a research area it is. During the program, several of my peers were confused by one of the lectures. I took it upon myself to prepare notes and give additional talks at night on the prerequisite information. By doing so, I was able to gain practice as an instructor and they were able to better understand the material.

For seven weeks afterwards, I attended another highly selective research experience for undergraduates, the NSF REU at the University of Chicago. Around 30 non-UChicago students were accepted to work throughout the summer on a personalized topic. I worked with Dr. André Neves and one of his graduate students. Professor Neves and Dr. Fernando Marques (of Princeton university), who jointly solved the Willmore Conjecture in 2014, have been major figures in minimal surface theory. While at UChicago I read through "A Course on Minimal Surfaces" by Colding and Minicozzi and subsequently wrote a 20-page paper. In it, I provide exposition on advanced minimal surface theory and prove an important compactness theorem. Though instrumental in modern min-max theory, no formal proof had been given yet. At the end of the program, I gave a 15-minute talk on basic minimal surface and min-max theory.

These programs gave me valuable insight into the social dynamic of a research career. Throughout UChicago's REU, we all gave each other critical feedback on our work and helped each other with the material we had to read through. Even though I work in a vastly different field from my fellow participants, they all helped at some point. Conversely, I was also able to help them, and learned a lot about other areas of math during my time there. Developing such relationships is vital in succeeding as a graduate student. The path will be hard for all of us, and the best way to succeed is to empathize and help each other through it.

Broader Impacts: In addition to teaching and researching, one of my service-oriented career goals is to help combat math anxiety. A student's aversion to math causes them to shy away from these courses, and a lack of problem-solving skills can develop. I often get asked why I even want to go into math; after all, society in general does not like it. To this I say, it is important that I become a professor so that I can teach math. It is the most direct way for me to help instill logical thought processes into my students and help them gain an appreciation for this remarkable subject. I have already made progress towards this goal in several ways.

After taking Honors Calculus III, my professor approached me and asked if I would help him prepare a solutions manual for the course. Despite it being a daunting task, I agreed. In just over three months, I wrote about 350 pages of solutions. Writing the manual not only provided an opportunity to strengthen my Calculus III knowledge, but also to combat my own math anxiety. I would have to be confident in my work, because the professor only had limited time to review the solutions. The classes (about 35 students per semester) who used it have reached out to me and thanked me for my valuable work. It clearly helped alleviate their stress – the most recent class received some of the highest grades since it began.

Every year, I offer to read my high school calculus teacher's math IB students' Internal Assessments (IAs). These are 15-20 page long math research papers which give students the chance to explore a subfield of math that interests them. I have directly observed their intimidation of math – they often choose an easy area out of fear and think that anything harder is out of reach. I believe this fear, especially in conjunction with stereotype threat given that more than 80% of the student body consists of minorities, is learned but can be reversed.

I am serving as Vice President of UF's Math Society. As VP, I help oversee the club and give advice to younger students. I am currently organizing an undergraduate research panel to increase involvement, giving a talk on REUs and how to apply to them, and overall assisting with mathematical outreach. For example, I am working with the department to implement an honors "concentration" for math majors, designed to select top math undergrads and help them get a head-start on their research careers. As part of this, I am pushing for the creation of an undergraduate math seminar course, which will give students the chance to hear seniors present their theses, see what undergraduate math research is like, and learn how to get involved in it.

Future Goals: When I was 14, a cardiologist told me that I would be dead by now. The anxiety produced by this – that I could die at any moment – initially drove me to work hard. I wanted to contribute something meaningful in my short life, and I did not have time to fail. Indeed, in 2017, I suffered a cardiac arrest two years after an operation. At the time, CPR was unsuccessful on all patients of the same operation. I am the only survivor. Ironically, this resulted in a coauthored paper with my surgeon currently accepted in a top medical journal. Nevertheless, I have and will continue to work diligently and refuse to waste my second chance at life.

I plan on continuing to work in geometric analysis in graduate school. I am currently interested in surfaces of constant mean curvature, which include minimal surfaces and Delaunay surfaces. Professor Menezes – Dr. Marques' spouse – also studies minimal surface theory at Princeton, and I hope to work with her. Entering a field with a plethora of older, male professors, I especially want to work with her because I have never had a woman math professor at UF.

I aim to combine my teaching experiences in my professional life. As a graduate student I will continue to visit local IB high schools. I will use the basics of my research to teach a different approach to math. Instead of honing mechanical solutions, I want to push for conceptual understanding. By researching geometry, I will be able to showcase high-level problems at an intuitive, visual level. I will support students like me who are affected by math anxiety and hope to inspire an appreciation for math.

Receiving a grant from the NSF will help me achieve my goals in numerous ways. Having funding means that I could focus personal time and money towards research and mathematical service: improving math pedagogy, visiting local high schools, and more. I understand that my research will mostly be important in the mathematical community – perhaps it will have some applications later, but I cannot predict that. I hope, though, to have an impact at large by motivating students to, instead of fearing math, accept it, familiarize themselves with it, and strengthen their confidence with it.