Teaching Statement

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While at Indiana University, I have acquired extensive experience as a teacher and communicator of mathematics. In particular, I have been the instructor of record for nine sections of five different courses. This has afforded me many opportunities in which to refine my approach to teaching mathematics, and these experiences have taught me that being a successful teacher requires a multifaceted approach in the classroom. As an instructor it is critical that I ensure that my students are exposed to the material through a variety of methods and have a positive and cooperative environment in which to learn.

In many of the mathematics courses that I had taken as an undergraduate and graduate student, the only way that the material was presented was through lecture. While in some sense standard, this approach is often employed with little to no thought to the engagement of the students, and so in the courses that I teach my approach is more proactive with regards to student engagement. Namely, in all of the courses I teach, I try to incorporate aspects of guided discovery, that is, allowing the student to "learn by doing" (with some assistance from myself), rather then presenting the material entirely through lecture or other media. In particular, one of the most common tools I have used in the past are worksheets, with the intent of reinforcing the material in the course through scaffolding via guiding questions. For example, while teaching J111 - Introduction to College Math, I created a worksheet developing and explaining the various ways of counting outcomes of random experiments (permutations, combinations, and related methods). This sheet gradually worked up from basic examples, like ordering different letters into words, up to more complicated ones. It was clear that this worksheet had its intended effect, as on the corresponding exam my students all did exceptionally well on those problems related to counting and probability.

Another example comes from when I was the instructor of record for M106 - Math of Decision and Beauty. Briefly, M106 is intended for general education students, but tackles a number of topics which are not seen in typical mathematics curricula, such as game theory, voting theory, and even elementary projective geometry. During the entirety of the course, I was especially careful to try to structure a discovery-based approach to the material. During the game theory portion, I gave the students monopoly money, and had them play some of the various games that we were modeling in lecture. To give them incentive to win, the amount of monopoly money they had at the end translated into some amount of extra credit points. Further, during the voting theory portion I allowed the students to vote for a class president using a voting system of their choice. To make things more interesting, they were also encouraged to try to rig this election using a handful of strategic voting tactics discussed in the course. I believe that this approach had a very positive impact, both on their relation to the material, as they were one of my highest performing classes I've taught, but also in their experiences in the classroom, as I believe that it helped create a positive and encouraging environment for them to learn.

Building on the examples above, I also believe that getting students to work together is another important aspect of my teaching. As such I always try to implement my worksheets or other approaches in a collaborative setting. This has many benefits besides helping the student establish relationships among their peers. To many students, hearing an explanation of a concept from a classmate often carries more weight then from the instructor. Conversely, a student having to explain a concept to a classmate forces them to internalize and understand a concept beyond just following an algorithm. This also has some self-correcting tendencies as well, as misconceptions or a lack of understanding around certain concepts becomes a discussion between members of the groups, and so can be corrected by another student, or the instructor if necessary. This "real-time" correction of errors and misconceptions also has the benefit of improving the student's grades, as errors and misconceptions are corrected before doing the homework for that portion of the course.

Of course a crucial part of maintaining such a collaborative environment is moderation from the instructor. While guided discovery as I described above has many benefits, my previous experiences have demonstrated to me that such approaches need careful supervision. Often such approaches are time intensive, so they must be planned carefully, and without enough support the students can become overwhelmed and discouraged. Such support requires a careful balance, you do not want to give them the answer and prevent them from finding their own explanation, but also one cannot let them drift too far down paths that lead to dead-ends. My most valuable experience learning these lessons was actually an assisting/grading assignment. I had been assigned to assist for a Euclidean geometry course intended for secondary education majors. The professor had decided that the entire course would be centered around guided discovery; the students were split into small groups, had assigned reading, and from that reading they were expected to pose and answer questions, some of which came from the text, while others were posed by myself, the instructor, or even other groups of students. My job was to guide them in the right direction by asking probing questions, giving suggestions, and sometimes just by being a friendly and encouraging presence. At first the students were reluctant, but after a few weeks they began to ask more and more questions and express a genuine desire to have them answered. This experience has taught me how to properly guide students in a more exploratory-format beyond just group work detailed in the previous paragraph.

Another factor in my experience as a teacher is my experience teaching courses for both the Groups Scholars and 21st Century Scholars program at Indiana University (indicated by a "J" in their numerical identifier). Both of these programs are intended for first generation college students and those who come from lower socioeconomic or underrepresented backgrounds. These courses required different approaches to instruction then my other courses, for the simple reason (among others) that many of these students were not offered the same quality of education that many more traditional college students were. Many of the courses were considered to be remedial in nature and so many of the students believed that they already acquired much of the knowledge and skills needed to pass the course, and as such were more difficult tot engage then those students not in the J-courses. For myself, an important part of teaching these courses was engaging the students who held these preconceived notions about the course, and indeed much of my experience and techniques that I employ to engage them were developed in these courses.

Undergraduate Mentoring

Another aspect of undergraduate education that is important to me is undergraduate mentoring. Among what I consider to be my most important contributions to the mathematics department at Indiana University is my involvement to the Directed Reading Program (DRP). The DRP pairs an undergraduate with a graduate student for an independent study on a mutually-decided subject for the duration of the semester. This provides the undergraduate valuable experience learning in a less-structured environment, and also provides the graduate student valuable experience being a mentor. Currently I am the director of the DRP at Indiana University.

To me, my involvement in this mentoring program is very personal. I attended a large state university for my undergraduate education, and due to its size, experiences such as reading courses or even relationships with professors beyond the formal student-teacher relationship were uncommon. Eventually, I became friends with a graduate student who took me on as an informal mentee. By letting me explore a subject as far as I could go, and then giving me problems to think about or suggestions to overcome a sticking point, they helped me explore my various interests in mathematics, allowing me to gain exposure and mathematical maturity far beyond what I would have obtained through normal coursework. To this day, I credit much of my success and passion for mathematics to their willingness to engage with me, as well as their approach to being a mentor. Upon entering graduate school at IU, I immediately recognized the enormous boost this afforded me, and so I wanted to ensure that I was able to provide a similar positive experience for other

undergraduates. The directed reading program at that point was newly established at IU, and I was extremely grateful to be an active part of its formation.

An additional impact that this mentoring program has is that of diversity in mathematics. For any individual, a positive mentor-mentee relationship provides the mentee with an enormous amount of mathematical and personal confidence in their abilities. In particular, such a strong relationship is known to be one of the most important factors in the retention of minority and underrepresented groups in mathematics, and so I expect that a proactive approach to mentoring such individuals will help create a positive and enriching atmosphere for them to thrive.

During my involvement, I have mentored two projects, both with the same student. The first was an introduction to algebraic geometry using a problem-based approach, and the second was an advanced number theory project on elliptic curves. During these projects I proactively tried to develop a positive relationship with my mentee, as I was well aware of how important and impactful such a relationship could be. I can say proudly that I believe I succeeded, as they went from an undergraduate who had little idea of what they were interested in to a graduate student pursuing a thesis in arithmetic geometry; they have confided to me that my mentorship was a significant factor in their decision to continue in the subject. After mentoring these two very successful projects, I took over as the coordinator of the DRP at Indiana University.

In the future, wherever I end up, I hope to bring some version of this program with me or become involved in its equivalent. At institutions which primarily serve undergraduates, the lack of adequate numbers of graduate students clearly prevents exact clones of the program from working, but there are several alternative formats that I think will work just as effectively. For one, having a "learning seminar" with supervision from myself is an excellent way to introduce several undergraduates at once to new material. Coupled with the tried and true method of individualized reading courses and undergraduate research, such a program could have a very positive impact for many.

Additionally, in the Spring of 2022, I will be running a project in the Indiana University Laboratory of Geometry. This program has a similar goal as the DRP, but instead of a focused independent study, this program aims to have the students explore (with careful supervision) a question in higher mathematics with the goal of publishable research. I have proposed a project to study the lines on real cubic surfaces. This project, while formally in the realm of algebraic geometry, would only require the students to be comfortable with multivariable calculus and the use of a computer algebra software. I explain more about this project and my planned approach to supervise this in my research statement.