Teaching Statement

Otjimbingwe, Namibia

It was a hot summer day and I was feeling proud of a lunar tides demonstration involving two students and three ropes. But then a bright student raised his hand,

"Sir, I don't believe that. Everybody knows water moves because it is alive."

This was not an objection I had anticipated, and it immediately ignited a heated discussion of how absurd it was to suppose that something 400,000 km away could affect anything at all, and degenerated into various statements starting with "My ouma (grandmother) says that…" I had hoped to finish the chapter that day, but this was too good an opportunity to learn something important.

After regaining control of the classroom, I had them break into groups and try to brainstorm an experiment that would falsify their hypothesis. When we came back together, we agreed that we would carefully pour water onto the concrete walkway outside the classroom—if the water were alive, it should move.

I was mentally rehearsing a dramatic speech on the power of falsification and the inexorable progress of science when, to my horror, the water slowly started flowing. It turned out the walkway was slightly inclined! The resulting roar of celebration was perhaps a step back in mastering the curriculum, but I like to think it was a stride forward in creating critical, independent thinkers.

Training Critical Thinkers

I spent two years teaching mathematics and physical science in a rural high school in Namibia with the Peace Corps. This proved to be a formidable challenge with high stakes. Following grade 10, students took a national exam to determine whether they could continue their studies—historically, most failed.

The core of my philosophy is to teach critical thinking in an active learning environment. This was forged partly as a reaction to the prevailing strategy in Namibia, which tailored teaching to the national exam in a lecture format, and emphasized rote memorization. I wanted to try a different approach, and negotiated to see a class of students through their mathematics exam, starting from grade 9.

I focused on problem solving, critical thinking and synthesizing concepts. Students regularly worked in groups on in-class activities that promoted active learning. While other students learned tricks for specific classes of exam problems, we learned algebra from the ground up, and how to translate real-world problems into mathematically tractable equations.

This approach faced a huge inertia. The educational system had never asked this of the students before, and for months all of their outward signs of progress were significantly behind those of their peers. But gradually they gained confidence and analytical skills. By the time of the exam, they were able to tackle broad classes of problems. I am proud that **in a year where more than 80% of students in the nearest town *failed* the mathematics exam, over 80% of my village students passed.**

Engaging the Scholarship of Teaching and Learning (SoTL)

Over these two years in Namibia, I built up effective teaching practices and extensive experience developing course material and student-centered activities, but it was largely by trial and error. Graduate school opened my eyes to the SoTL, and I actively sought out workshops and courses (see CV) to help me grow as an educator.

During my time at Cornell, I worked as a teaching assistant for several introductory astronomy courses. While this represented a reduced teaching responsibility, it was a fantastic laboratory for experimenting with and practicing various teaching techniques. For example, after becoming interested in peer instruction and in-class feedback[1], I incorporated regular think-pair-share questions[2] into my sections. I found that these helped promote active learning[3], increased student participation[4], and provided me with great feedback for pacing the class.

Graduate school also provided a great opportunity to obtain teaching feedback. In 2010, as the head teaching assistant for introductory astronomy, I organized opportunities for each of us to observe one another's sections, and exchange ideas afterward. This helped me better structure my group activities, and **that year I was recognized with the department's teaching excellence award.**

On a broader level, no single practice has sharpened my teaching more than the habit of developing clearly articulated goals for every course decision I make[5]. Doing this ahead of time purposefully binds my teaching and assessments to the learning outcomes I deem valuable.

Developing Strong Writing Skills

Writing skills are not only crucial for professional scientists; employers consistently rank oral and writing skills as highly or more highly than any technical or quantitative skill[6]. Writing therefore belongs at the core of a liberal arts education, and writing in the disciplines has emerged as a powerful means to this end[7,8].

To develop these teaching skills, I designed a first-year writing seminar on life in the universe, incorporating the pedagogical principles described above. **I submitted it to Cornell's Knight Institute for Writing in the Disciplines, and I was selected to teach it as one of two Buttrick-Crippen fellows across all Cornell departments.**

For example, as an application of the concepts we covered in habitability and planetary atmospheres, and as an immediately relevant exercise in critical thinking, we explored the topical "debate" over global warming. To prepare them for an essay on the topic, I prepared an activity that provided several related (and unrelated!) facts, and required them to critically assemble them into sound arguments in groups. Students were engaged, and the outcomes were fantastic. I overheard several discussions where students corrected *each other* on logical fallacies I had pointed out on previous essays. I subsequently submitted this activity to Cornell's Knight Institute, where **it won the award for the best writing exercise across all first-year writing seminars.**

An Inclusive Classroom

In Namibia I had classes with students spanning a wide range in age, tribe, and English-speaking ability. These factors posed challenges, but I enacted several efforts to make my classroom more inclusive. In particular, I regularly strived to create opportunities that would allow and encourage quiet students to participate, and tried to cater to diverse learning styles through a mix of demonstrations, in-class activities, and interactive lectures. I have also found that the most powerful way of helping marginalized students is simply reaching out and personally connecting with them.

On the first mathematics test I gave my class, a student named Neville had the lowest mark, scoring below 20%. He paid little attention in class, partly because of his poor English. But I played soccer with the students, and took opportunities to talk to him outside of class. Rapidly his interest in my course grew, and he found he was in fact quite proficient in the subject. In grade 10 I invited him to join a group who would study in my class at night (while I studied for the physics GRE!). In the end, Neville achieved one of the top 10 grades in the school on the mathematics portion of the national exam, and moved onto grade 11 along with every student in the study group.

While university classrooms are not directly analogous, I believe this experience, together with my native Spanish and passion to push students to their full potential, will help me effectively tackle diversity challenges.

Courses

At Cornell I thrived in all the first-year graduate physics courses, as well as a broad curriculum across dynamics, planetary science and astronomy. I would thus be eager to teach across the vast majority of any physics and astronomy curriculum.

I would also love another opportunity to teach the first-year writing seminar mentioned above. Similar writing-based alternatives to traditional introductory astronomy courses at Cornell were highly popular, and my particular seminar filled up within an hour of enrollment opening.

Finally, I would jump at the opportunity to develop additional upper-level undergraduate, cross-discipline courses in planetary physics, machine learning, and non-linear dynamics and chaos. I believe that these would have broad appeal and utility across the physical sciences, and could open doors to other fruitful cross-department collaborations. The machine learning course would also provide applied quantitative and numerical tools for students looking to transition to industry, as well as to those looking to tackle the looming ‘big data’ challenges currently facing the physical sciences.

References

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